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THE ATCHISON STONE CUTTING MACHINE.

THE annexed engraving gives an idea of the machine for dressing plain surfaces.

By the use of these machines, the work of planing granite is greatly lessened, and the surface of all kinds of stone more satisfactorily finished, both for building purposes and polished work.

From experiments already made, the amount saved in dressing stone by this method is proved to be more than half over hand labor.

The tools, two in number, are arranged in a strong head-piece, attached to a moving platen, similar to the iron planing machine.

This platen, with the head-piece, is made to move forward and backward over the stone, and the tools, having a perpendicular, reciprocal, rotating motion, cut the surface at the rate of not less than 6,000 blows per minute. The rapidity of this motion is of great value in the use of the tools—the wear is less than one-half compared with hand work. The tools are semi-circular in shape at the edge, made of Jessop's steel, and can be used constantly for at least forty-five minutes without changing; thus one set of tools will cut not less than 270,000 blows without resharpening.

The machine is simple in construction, and requires but little care. "One-horse power" only is needed in the running of each.

One man can operate three machines, and sharpen his own tools, which sharpening is done readily by the use of a "die," a new and valuable method not heretofore attempted.

Among the advantages claimed for this machine are:

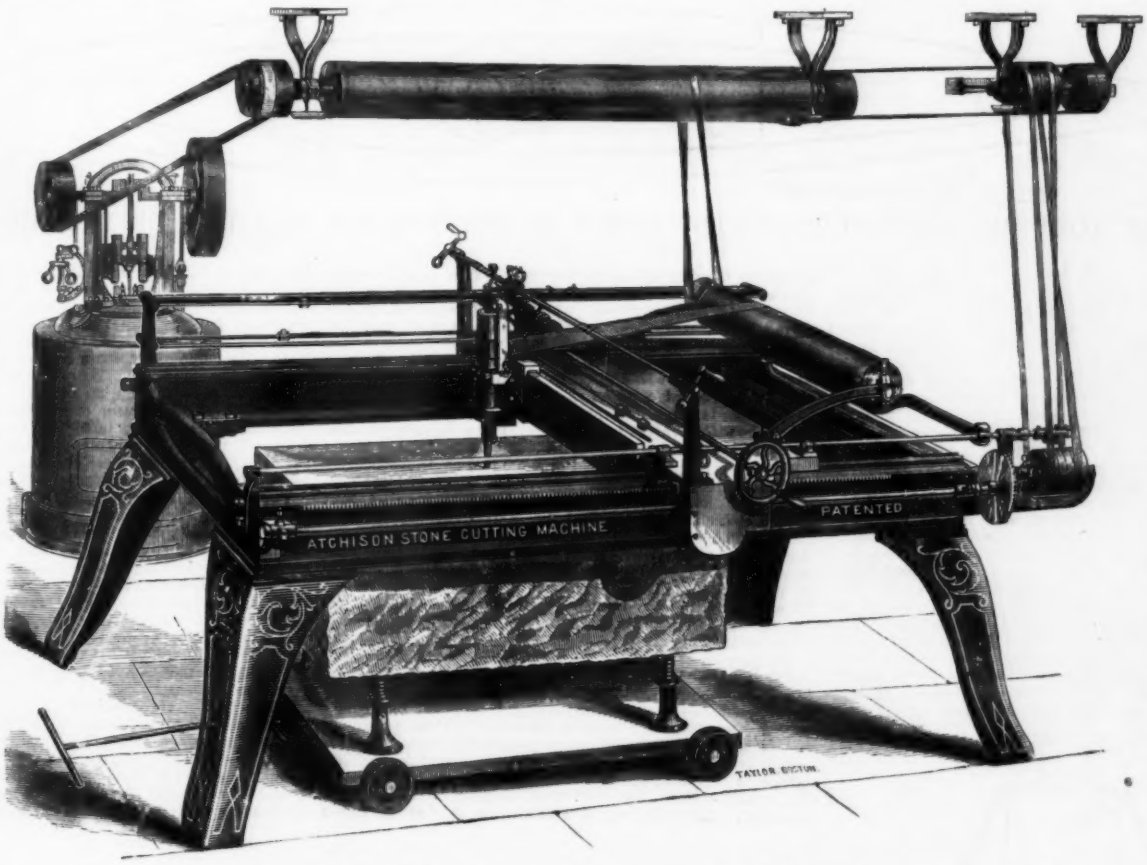
1. The slight cutting blows produced by this peculiar motion leave the surface absolutely "solid" and free from "stunning"—so important for polished work.

2. All "wind" or irregularity of surface is positively overcome, without the tedious process of "sighting" or measuring.

3. The edges of the stone are evenly and perfectly cut without "chipping."

4. This principle is applied to machines for ornamental as well as plain work, and the rapidity and accuracy in cutting mouldings, cornices, ornaments, letters, etc., etc., on all kinds of stone, place them in the foreground of all attempts hitherto made in this direction, thus entirely overcoming the insurmountable obstacles in the way of using machines for ornamental work.

5. The great saving of time and wear of tools are among the leading features claimed for these machines. Also that contractors by using them can accomplish in hours what it takes days to do in the old way. The inventor, R. R. Atchison, 26 Charlestown Street, Boston, has devoted the best part of over four years to the task of working out this successful plan for planing granite by machinery.



THE ATCHISON STONE CUTTING MACHINE.

THE DEEP MINES OF THE WORLD.—The deepest mine now being worked in the world, probably, belongs to the Adalbert mine, Austria, in which the workings are carried on through a perpendicular shaft 1,000 meters—3,280 feet deep. This is a lead-silver mine, and has been worked many years. The next deepest mine on the continent of Europe is the Viviers coal mine in Belgium, 2,847 feet deep. This mine was explored to a depth of 3,586 feet, but no coal having been found, all below the 2,847 level has since been abandoned. The Dunkirk colliery, Lancashire, England, has been opened to a depth of 2,834 feet, and the Rosebridge colliery, same locality, to a depth of 2,458 feet, these being the deepest mines yet opened in Great Britain. The Yellow Jacket is the deepest mine opened on the Comstock lode, its lowest level being now about 2,500 feet below the surface at the mouth of the main shaft.—*Min. and Sci. Press.*

THE HERRESHOFF TORPEDO BOAT.

A TORPEDO boat of special construction and embodying several novel and important features has just been brought over from the United States to this country by her designers and builders, Messrs. Herreshoff, of the Herreshoff Manufacturing Company, Bristol, Rhode Island, U. S. A. This vessel was built to the order of the British Government, and with her some interesting trials were made at Erith in January last. There were present upon the occasion the French naval attaches, Captain de Cuverville and Lieutenant de Bretizel, as well as several other gentlemen interested in the question of torpedo warfare. The boat is 59 ft. 6 in. long by 7 ft. 6 in. beam and 5 ft. 6 in. deep, with 1 ft. 3 in. draught of water, there thus being 4 ft. 3 in. of freeboard. Her working draught, however, is 4 ft. 6 in., as the screw and rudder are both placed below the keel. The vessel is constructed with five water-tight bulkheads, and her hull is of composite construction below the water line, having a steel framing covered with wood planking. The upper part of the hull is wholly of steel, the plates being $\frac{1}{8}$ in. thick, the top sides sloping inwards, and the upper work forming a protective superstructure for the crew and machinery. She is propelled by a screw, which is placed beneath the vessel in a central position, and which is driven by a direct-acting condensing engine placed in the forward part of the boat. The diameters of the steam cylinders are 10½ in. and 6 in. respectively, with a 10 in. stroke, and they are of 100 horse power estimated. There is an independent feed pump and air pump. The stoke-hole is inclosed, and is supplied with air by a Sturtevant blower, which is driven by an independent engine of 2½ horse power. The propeller is a two-bladed screw, 38 in. in diameter and 5 ft. pitch, the screw shaft being 23 ft. in length. The vessel is steered by means of a balanced rudder placed a short distance from the stern and under the ship, the helmsman being located in a stern cabin with a protected look-out raised just above the deck. The hull and machinery together weigh 6 tons, but with the working crew of four men and fuel, stores, and two torpedoes on board, the boat weighs about 7¼ tons.

Steam is supplied by a Herreshoff coil boiler, which constitutes another novelty in this boat. This boiler consists of a circular combustion chamber, which in the present instance is 4 ft. in diameter internally, and within which is a coil of about 300 ft. of 2 in. pipe coiled to nearly the diameter of the chamber. This coil is continued at the top so as to form a kind of dome under the cover of the combustion chamber. By the side of the boiler is a separator, into which the steam passes before it goes to the engine. The water from the feed pump is admitted at the top of the coil, and during its course to the bottom the greater portion of it becomes converted into steam. Having passed through the entire length of the coil, the steam and water are discharged together into the separator, in such a manner that the water is entirely separated from the steam, and can be blown off as required. The steam is taken from the top of the separator, and returns through a short coil placed inside the combustion chamber, where it becomes superheated, and is led thence to the engines. It is claimed for this boiler that it cannot explode destructively, inasmuch as there is but a very small quantity of water in it at any time, and that it is distributed along the entire length of the coil. A rupture at any point would only be attended by a moderate blowing off of steam. The rapid circulation of the water is found to prevent the deposit of salts, the surplus water not converted into steam carrying with it all impurities. A good working pressure can be obtained within a few minutes of lighting the fire, and the boiler can be blown off in a few seconds. The large combustion chamber enables the full economy of the fuel to be realized.

The boiler on board the torpedo boat under notice is intended to be worked at 160 lbs. per square inch, having been tested up to five or six times that pressure. Upon the occasion of the recent trials, the working pressure was 80 lbs. per square inch, the number of revolutions of the engine being 350 on the average. The run made was from Erith pier, through the Lower Rands into Long Reach on the two-mile course. The object of the run was mainly to show her maneuvering qualities, no attempt being made to develop or try her speed, which, however, was good. It was demonstrated that the boat could be propelled ahead or astern with equal speed, and that she could be steered in either direction with equal facility. She was turned in a circle which was of a diameter of about three times her own length, was stopped dead when going at full speed within a distance which was—as near as we could judge—equal to her own length, and was put through other evolutions which she performed in a very satisfactory manner, notwithstanding the exceptionally rough weather which prevailed, and which proved her qualities more satisfactorily than a calm and smooth water could have done. She is the second torpedo boat that has been built and fitted upon the Herreshoff principle, but about a hundred boats of various classes upon this principle are in use in the United States, including tug-boats, which are reported as answering exceedingly well. The present boat was, as we have said, built for our Admiralty, and is guaranteed for a speed of 16 knots. Her speed trials will shortly be made, and we shall report the results. Should they prove satisfactory—and there is no reason whatever to doubt that they will—our Government will have made a very useful addition to their torpedo fleet. The sea-going qualities of the boat were well tested in the run she made from her builders' works in Rhode Island to New York, when a good speed was attained.

We give engravings which will further explain the peculiarities of this very interesting vessel, and will repeat some of the particulars. The boat is 59 ft. 6 in. long, with 7 ft. 6 in. beam, and it has a composite hull with timber planking below the water line, and a steel skin above, while there is also a steel superstructure of the form shown, covering the machinery and men. This superstructure is shown by Figs. 1 and 3, on next page, the latter figure also showing the manner in which the junction is made between the steel upper skin and timber planking. The planking of the lower hull is of white pine, $\frac{7}{8}$ in. thick, and the skin of the upper part is of the best homogeneous steel plates, $\frac{1}{8}$ in. thick.

The composite system of construction we have described was adopted because a wooden covering below water can be made and kept more smooth than a steel one, while it is at the same time more durable on account of the very small thickness of steel which would be admissible in order to keep down the weight. It is proposed hereafter to cover the bottom with copper or Muntz metal when desirable. The lines of the hull are nearly alike at the bow and stern.

The boat is propelled by a compound engine of the inter

mediate receiver type, and having a 6 in. and a 10½ in. cylinder, each with 10 in. stroke. The air pump is 3 in. in diameter and the feed pump 1½ in. in diameter, both having 5 in. stroke and both being double-acting. These pumps are driven by a small independent horizontal engine, not shown in our engravings. There is also another independent engine for driving the fan blower, this engine being a small vertical of 3½ horse power, placed as shown in Fig. 1. The fan supplies air at a pressure of about 1½ in. of water to the closed compartment in which the boiler is placed.

The boiler is, like many other details of the boat, of a special type patented by Messrs. Herreshoff. We shall in an early number publish detail views of this type of boiler; in the mean time we may state that the boiler fitted to the torpedo boat forming the subject of the present notice consists of a coil of wrought-iron pipe 2 in. in diameter and about 300 ft. long, this coil forming a kind of combustion chamber above the grate, which is 4 ft. in diameter The feed is supplied to the upper end of the coil, and the mixed steam and water escaping from the lower end passes into a separator where the water is deposited, the steam being then led through a short superheating coil on its way to the engine. The separating chamber of the boiler is placed in the engine-room, where the blowing-off valve can be managed by the man who attends to the feed pump and fan engine.

As will be seen from Fig. 1, the engine is placed well forward in the vessel, and the shaft runs at an inclination through the bottom of the boat. In order, however, to counteract the effect of running a screw with a steeply inclined shaft, the latter is curved throughout its length, so that the after end is brought nearly horizontal. The shaft is of steel, and is kept to the curve shown by being run in a brass tube which is bent to the desired curve, and which forms a kind of continuous bearing from end to end. The tube just mentioned extends to within about a foot of the engine, and the stuffing-box is fitted to its inner end. This plan of employing a "sprung" shaft to communicate the motion to the screw is a bold departure from ordinary practice—as indeed are many features of the boat—but it appears to answer well, and the friction involved by this arrangement is stated not to be in any way excessive.

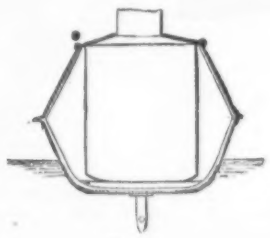


FIG. 3.

The curved tube forming the shaft bearing is securely fixed inside a double-walled copper chamber, which projects below the bottom of the boat, and serves the triple purpose of a support to the shaft, a fixed center-board or false keel, and last, but not least, a surface condenser. The keel formed by the condenser being at the center of the length of the vessel, forms a kind of pivot on which the boat may be turned. The exhaust steam from the engine enters the condenser near the forward end, and the suction pipe to the air pump draws from the after end.

The screw is 38 in. in diameter, with 5 ft. pitch, and as will be seen from Fig. 1, it is situated more than one-third the length of the vessel from the stern. Owing to its position, the screw is of course always working in solid water, and its power of suddenly starting or stopping the boat is thus greatly increased. By reversing the engine the boat can be stopped in three-quarters of its own length.

The rudder, like the screw, is placed in an unusual position, it being below the bottom of the boat, but close to the stern, as shown in Fig. 1. The rudder is partly balanced, and it is so mounted that it is free to turn in any direction, either forward or backward. The steering wheel is situated below a small conning tower, as shown, and the motion is communicated from it to the rudder head by means of a chain and rag wheel. When the boat is going ahead, the preponderating side of the rudder is toward the stern as usual; but when going astern the rudder is allowed to swing completely round, so as to bring the preponderative part toward the bow. Under these circumstances the steering when going astern is as easy as when going ahead. The boat, when going either backward or forward, can be turned in a circle, the diameter of which is about three times her own length, or about 180 ft.

The weight of the boat with fixtures is 6 tons, or with torpedoes and stores, 8 tons. The strength required for hoisting is given by the steel skin and the steel superstructure, while when running at full speed the boat is remarkably free from vibration, owing partly to the screw running in solid water, and partly to the curved form of the superstructure, which gives great stiffness to the ends of the vessel.

The improvements made in steam launches during the past few years have been almost always developments in the same direction, whereas the Herreshoff boat we have been describing is an improvement from a new departure, and the success which has attended its performances is, therefore, a matter of special interest. On Monday, January 20, the boat we have been describing was examined by the First Lord of the Admiralty, who was accompanied by Admirals Hood, Wellesley, and Sir Houston Stewart, and Mr. Barnaby, the Chief Constructor, who witnessed some experiments made with it at the Royal Victualing Yard. On this occasion the boat was hoisted by a crane with all stores and the crew on board, without showing signs of springing, and it was then lowered into the river, and steam got up to blow off at the safety valves in five minutes after lighting the fire. The speed attained was 16 knots. The boat was also tested for stability by placing a load of 1,700 lbs. on the gunwale, the results being highly satisfactory. The great handiness of the boat, and her powers of rapid stopping, starting, and turning were then shown, and Mr. Herreshoff was complimented on the highly successful results by the Admiralty authorities. Altogether the Herreshoff torpedo launch promises, from its powers of maneuvering and the great rapidity with which it can be got ready for use, to form an important addition to our naval resources, while its numerous special features give it particular interest from a mechanical point of view.

We give an engraving showing a section of a Herreshoff boiler, which will clearly explain its construction.

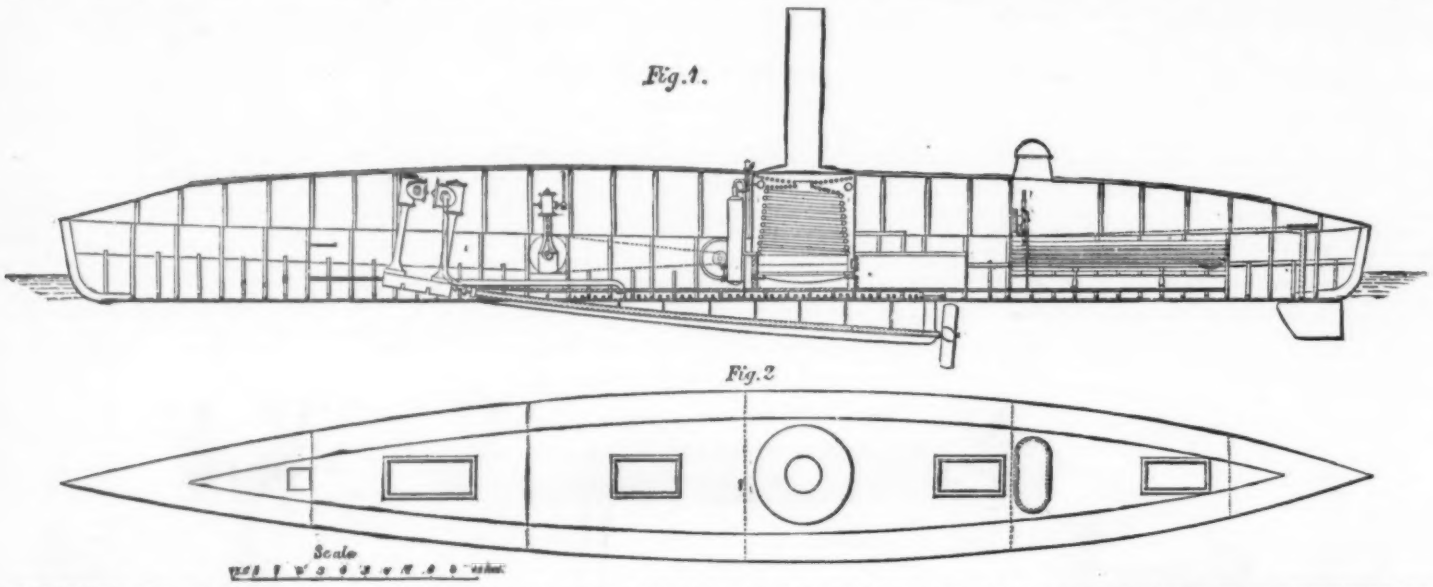
The Herreshoff boiler—or rather steam generator, as it is called—consists of a continuous coil of wrought iron steam pipe arranged in the form of a frustum of a cone, as shown in our engraving, this coil being placed above a fire grate, which is encircled by a dwarf wall of firebrick inclosed within a suitable casing, this brick-lined casing with the space within the coil itself forming a combustion chamber. The whole is inclosed in a double or treble shell or smoke jacket, with an air space or spaces between for insulation.

There are two forms of the Herreshoff generator, viz., those of the double and single coil. In situations where it is desirable to combine economy of fuel, and to have the generator in as small a vertical space as possible, the double coil is used. In situations where it is an object to economize height a single coil is used. Our engraving annexed represents a double coil of the most approved form.

In operating this generator water is delivered by the pump into the outside part of the flat coil, A, which coil serves as a feedwater heater, its inner end being connected to the top of the main coil, B, through which the water descends. As the water approaches the bottom, it becomes partly vaporized, and at the bottom of the inner coil the pipe merges continuously into the outer coil, C, through which the ascending steam and water pass to be finally delivered into the separator, D. On its arrival at the separator the water is almost steam, only 15 to 20 per cent. remaining in a liquid state. The amount of water here collected should be proportioned to its purity. Where seawater, or muddy or impure fresh water is used, 20 per cent. of the water that is forced into the generator is sufficient to carry with it all sediment which collects in the bottom of the separator, from whence it may be blown off at intervals. The rapidity of the circulation of the steam and water in the coils prevents lodgments or obstructions.

The end of the discharge pipe, E, entering the separator, is deflected in such a manner that the steam and water are projected against the sides of the separator, and a whirling motion imparted to them. By this operation the water is more quickly and perfectly separated from the steam. The water being heavier, it is thrown outward by centrifugal force against the sides of the separator, when it readily falls to the bottom. The steam occupying the upper and central portions of the separator escapes through the passage, F, to the coil, G, in which it is more thoroughly dried and superheated. It is then conveyed by the supply pipe to the engine or other uses.

The height of the water which collects at the bottom of the separator is always indicated by the glass water gauge, H, and the surface blow-off, I, is provided with an adjustable valve or steam trap, through which the excess of feedwater passes. The blow-off, J, is for the removal of sediment. If the boiler be used in connection with a surface condensing engine, the excess of water which is blown off



HERRESHOFF TORPEDO LAUNCH, RECENTLY BUILT AT BRISTOL, R. I., FOR THE BRITISH GOVERNMENT.

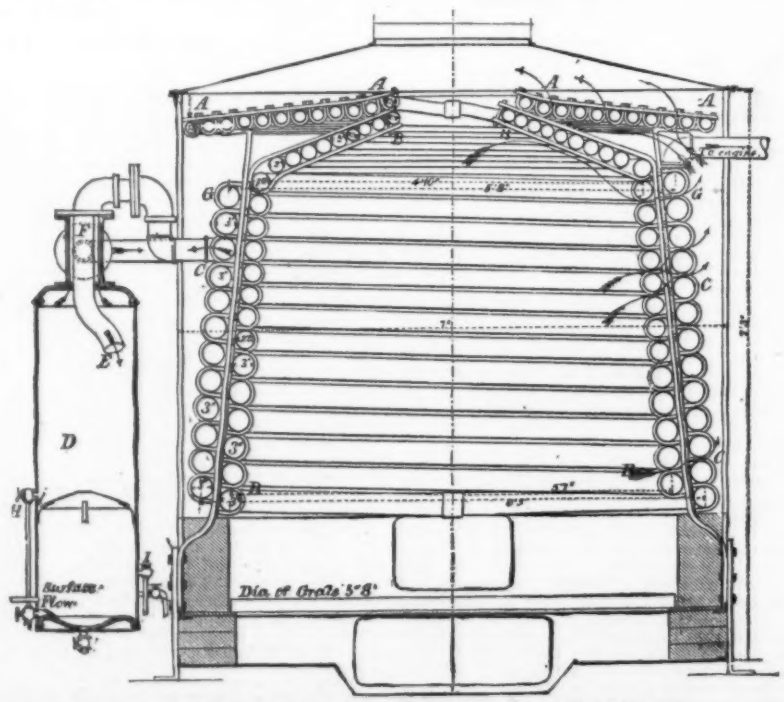


FIG. 4.—THE HERRESHOFF STEAM GENERATOR.

at the pipe, I, is returned again at the top of the coil, with the feed water arising from the condensation of the steam used by the engine. By this means no heat is lost by the escape of the excess feed water.

A very important feature of the Herreshoff steam generator is its safety, the amount of water contained in it being so small that were it instantly liberated it could do no damage. But instant liberation is out of the question; the most that could occur would be a forcing open of the pipe which forms the coil, and this would only be followed by a harmless blowing off of the steam. The separator is the only part of the boiler possessing anything like a large diameter, and its entire removal from the fire precludes a possibility of explosion. It can also be made of a strength far exceeding the practicable limit of steam pressure. The generator is also very compact and light, both valuable features in many situations. The coil can also be made oval, which form is better adapted for some situations; such as a very narrow steam launch or vessel.

It will be seen by our engraving that the whole space surrounded by the coils on the sides, and from the grate below to the coil above, is a clear unobstructed chamber for combustion. The importance of so large a space is particularly of value in the burning of bituminous coal, for perfect combustion of fuel cannot take place without the complete mixture of air which a large chamber insures. The flames and heated gases are not allowed to escape through the top of the coils, which are purposely made tight. All the products of combustion are forced to escape through the narrow spaces between the pipes which form the main body of the coils. These spaces are graduated, being larger at the bottom and decreasing as they approach the top. The heated gases, being lighter, rise in the chamber and are held there, their escape being only permitted by the spaces of the smaller size. The heated gases from within are thus finally divided, and each atom is brought into actual contact with the heating surfaces of the generator.

When it is desirable to stop the working of the generator for a longer or shorter period, the water contained by the coils is entirely blown out; the generator then remains perfectly dry and cannot be damaged by the action of frost.

The quality of steam supplied by the Herreshoff generator is, we understand, very good, it being delivered from the superheating coil perfectly dry. The degree to which the steam may be superheated is proportioned to the length of the superheating coil, which can be made shorter or longer according to the purposes for which the steam is used. The superheating coil is so situated that the steam passing through it cannot be heated to a degree which would be injurious to the engine.

The first use to which the generator we have been describing was put, and perhaps one which more nearly combines all its valuable points, is that of supplying steam for the propulsion of vessels. Its perfect safety, of course, is a valuable point in every situation, but especially so on a vessel, while the lightness of the generator is most advantageous, particularly in vessels of a small size. By the carrying of less weight they are more buoyant and seaworthy, and lightness is also one of the first elements of speed, while if used for tenders for larger vessels they can be more easily hoisted or lowered; or if desirable, the vessel can be brought with coal to the same state of displacement as vessels with other boilers, and will thus be enabled to perform a much longer voyage. The facility in raising steam, to which we have alluded, is a most valuable property, particularly in yachts and launches, where it is desirable to lose no time in starting from anchorage. But especially is this property of value as applied to torpedo boats. The fact of being able to get under way within five minutes' notice, to repel the sudden attack of an enemy, will be appreciated by all vessels in marine warfare. The ability to use seawater is also an advantageous point. It is often inconvenient, and at least annoying, to supply yachts or torpedo boats with fresh water for use in their boilers.

After the products of combustion have sifted themselves through the main coils, they arise on the outside of them, between the coils and the jacket. Near the top of the coil and directly in the path of the ascending gases the superheating coil is placed, and extract still further any valuable heat which they contain. Even after this the gases are not allowed to escape freely, but have to pass through the flat coil or feed water heater, the spaces between the pipes of which are larger than those of the main coil, so as to allow a free passage of the gases, which by this time are almost entirely deprived of their heat.

The reasons have already been given why the combustion of fuel in the furnace of the generator is so free under natural conditions. The heated gases are brought so quickly and directly into contact with the heating surfaces, and the coil itself contains such a small amount of water, that a degree of heat sufficient to generate steam is had almost immediately after lighting the fire. Sixty pounds pressure can be obtained in four or five minutes, and in six minutes 100 lbs. can be indicated.

Of course, an important question to be considered in connection with a generator of the type we are describing is its durability. In the case of the Herreshoff generator the sides of the furnace are lined with firebricks, and the fire is thus not allowed to come into actual contact with the coils, which are supported by the bricks at a distance of one-fifth of the diameter of the grate above it. The coils themselves are also so constructed that no injury can come to them through expansion and contraction, while it is now a recognized fact that the passage of steam over hot iron forms a protecting scale of black magnetic oxide of iron, which prevents injury of the metal beneath it from rust or corrosion. Messrs. Herreshoff affirm that the quality of the iron of which the coils are made improves by alternate heating and cooling, the iron composing the coil of an old generator being found to be tougher and stronger than when new.

Another use to which the Herreshoff generator has been put in America is for fire extinguishing service in towns and cities and large manufactories. The town of Bristol, in Rhode Island, where the generator originated, may be taken as an example of this system, which for power and efficiency is not surpassed in any city in the world. The following is a short description of it:

In a station house situated on the banks of the bay upon which the town is located, is placed a Herreshoff generator of about 400 horse power, which supplies steam to a pump having a steam cylinder 22 in. in diameter with 24 in. stroke. The pump has a diameter of 12 in. and 24 in. stroke. The whole town is intersected by a system of pipes laid underground with hydrants for the coupling on of hose at convenient intervals. The furnace of the generator is kept constantly charged with pine wood, and on the alarm of a fire the engineer on watch, who lives in the building, throws in a quantity of petroleum and fires away. The large pump is started in five minutes after lighting up, and instantly the water can be thrown upon the fire from any part of the circuit of underground piping under a pressure of 90 lb. to 100 lb. per square inch.

At the contract trial of the service eight streams were discharged from 1¼ in. nozzles 100 ft. high at a distance of five-eighths of a mile from the pumping station, and about 50 ft. above it. The generator used in connection with this system is of the following dimensions: Grate, 72 in., single coil of 550 ft. of 3 in. pipe. Some time ago the *City Press* noticed the fact that some hose stations were to be established in the city, and said when this was done, with the hydrants which were already established, London would be the best protected city in the world from fire. But let us examine the facts. The city hydrants have no more than the water company's pressure, about 30 lb. This would be very effective so long as the flames did not keep the firemen from carrying their hose into a building and playing directly on to the flames; but once the fire takes a good hold, and the firemen have to throw the water from the street, such a pressure gives a feeble and ineffective jet of water. By the Herreshoff system, within five minutes of an alarm of fire having been given, a pressure of 90 lb. in the water main is obtained in any part of the city. This, with a 6-in. main, the size used in Bristol, Rhode Island, would give an extinguishing power equal to at least six of our largest steam fire engines. No better proof of the efficiency of the system can be wished than the results obtained in Bristol, where it was first introduced. Bristol, like nearly all the New England towns, consists almost entirely of "frame" houses, *i.e.* built of wood. During the exceptionally hot and dry summers, common to the Eastern States, everything becomes as dry as tinder. Owing to the use of petroleum lamps fires frequently break out, but since the establishment of the Herreshoff system there has been but one fire of any magnitude; this, however, did not get ahead through any failure of the system, as there was a pressure in the mains of 90 lb. seven minutes after the first alarm.—*Engineering.*

STEAM DREDGER.

THE engravings represent the Australian Government hopper dredger Willunga, constructed by Messrs. W. Simons & Co., of Renfrew. The principal dimensions of this vessel are: Length, 183 ft.; breadth, 38 ft.; depth, 13½ ft.; hopper capacity, 20,000 cubic feet. It has two independent sets of compound engines of 50 nominal horse power, each driving its own screw propeller. The buckets excavate to 30 ft. depth of water, and lift at the rate of 350 to 400 tons of free soil per hour. After being satisfactorily tried at work on the Clyde, the vessel was filled with sufficient coal to steam out to Australia. It also carried all its dredging gear, and accomplished the voyage to Port Adelaide in ninety days.

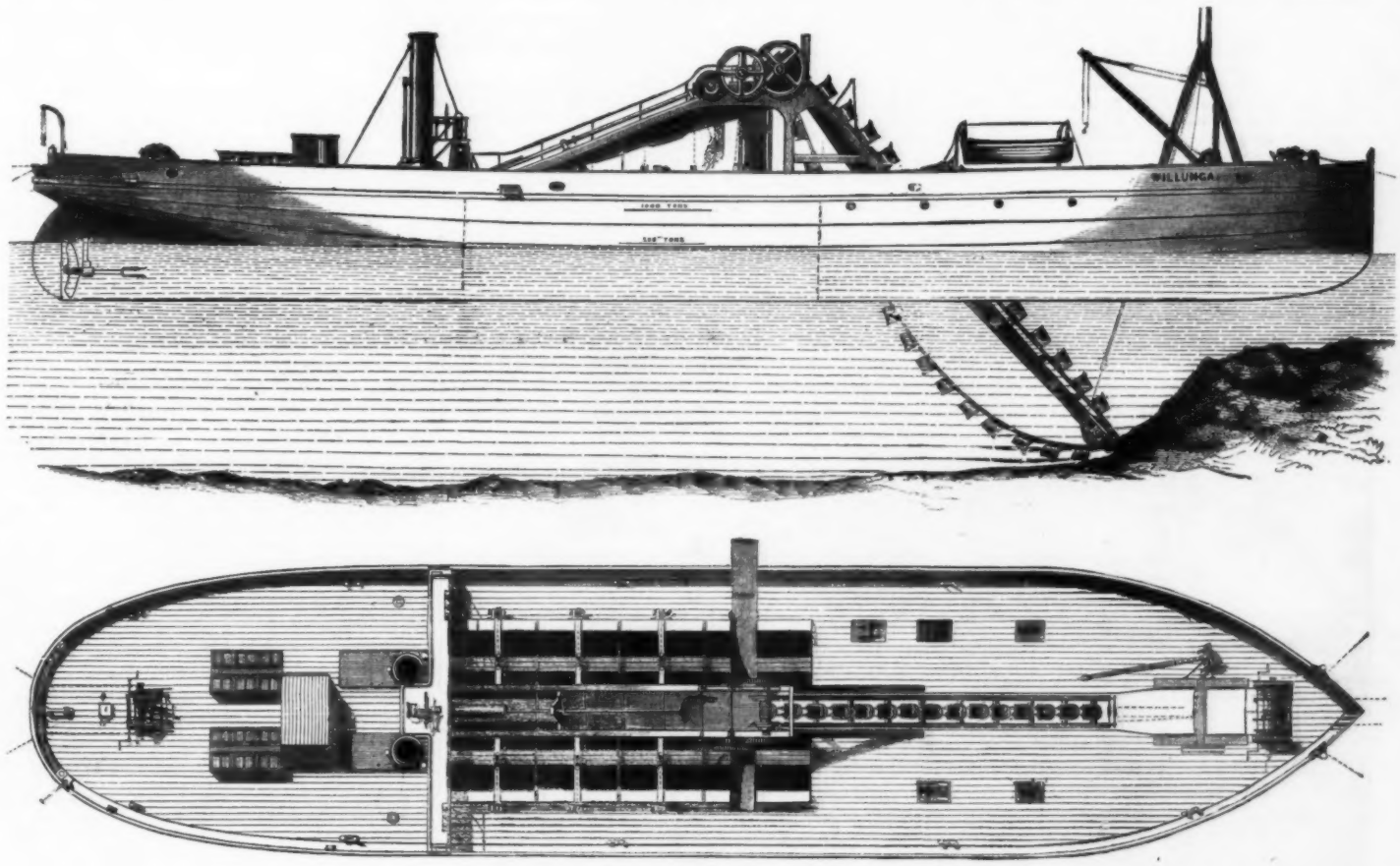
Regarding the Willunga, Mr. Hickson, C.E., the Government Harbor Engineer, in his annual report for 1877—published in the *South Australian Gazette* of 13th June last—states as follows: "The hopper dredger Willunga has raised at the rate of nearly six times as much stuff as our No. 1 dredger—on the old system—at rather less than a quarter of the cost; or putting it another way, the Willunga can do twenty-four times as much dredging work as No. 1 dredger at the same total cost. This is an important fact. Since June, 1877, this vessel has been employed on the outer bar, and recently completed a channel through the bar 150 ft. in width, with a depth of 20 ft. at low water springs. She is now engaged in widening this channel to 300 ft. All the limestone crust and soil raised by the Willunga was deposited in the gulf seven or eight miles distant."

The Willunga for some time has raised and removed 10,000 tons of soil per week from the exposed outer bar at Port Adelaide; her working expenses (at Clyde rates) for wages, fuel, and stores per week is £31 10s.; while a barge loading stationary dredger, and its two steam hopper barges, of equal power and capacity to the above, is fully double that of the Willunga, namely, £66 per week for crew's wages, fuel, and stores.

The cost of sending out an ordinary dredger and two hopper vessels to Australia is about £5,000 more then sending a hopper dredger, as the former fleet requires three crews, and to coal at nearly all the ports on the way out, *via* the Suez Canal.

In the monthly report of the harbor engineer for May last, published in the *South Australian Register* of 11th July, 1878, he states as follows: "The Willunga has been engaged at the outer bar, and notwithstanding several interruptions, had raised 30,655 tons, the cost of raising being 4d. per ton, and for depositing, 1¼d. per ton."

One of the most powerful barge loading Clyde dredgers, No. 9, attended by three hopper steamers, in the first seven months raised 104,700 tons of silt, which the three hopper steamers deposited; while the Willunga alone in the same



IMPROVED HOPPER STEAM DREDGER.

length of time raised 159,860 tons of the same kind of stuff, and deposited her own dredgings seven to eight miles off in the Gulf.

At Swansea the hopper dredger Abertawe in two years raised 93,173 tons of extremely hard till and clay, with large bowlders, and deposited her own dredgings five or six miles out in deep water, and has reduced greatly the cost of dredging. No. 7, Clyde punt loading dredger, in the same time—two years—raised 86,965 tons of hard clay, till, and bowlders; but a number of barges and a tug steamer were in attendance.—*The Engineer.*

ST. GOTHARD TUNNEL.

The small bronze turbines, which make 155 million turns per annum, after four or five years' service require but slight repairs. Turbines of iron and steel, under the same pressure, do not last over a year. The 16 air compressors supply air enough, under a pressure of 8 atmospheres, to supply 18 to 20 drills, and to ventilate thoroughly all the tunnel, of which about 8 miles has already been bored. On each side there are, night and day, many hundreds of workmen, as many lamps, and about 600 pounds of dynamite are used daily. The financial difficulties of the company are connected with other portions of the line. The works of the tunnel have not been interrupted a single day for six years, and the original estimates will probably not be exceeded, although many unforeseen obstacles have been encountered. The tunnel will probably be finished within eight years from its commencement. The stipulated time was nine years.—*Comptes Rendus.*

THE BEACON-TOWER OF LAVEZZI.

In the very middle of the Strait of Bonifacio, in the Mediterranean, there exists a dangerous rock, the surface of which is covered by but a few feet of water; behind it is the large, almost desert island of Lavezzi. On the 15th of February, 1855, this spot witnessed the greatest loss of life that has ever been known to occur from the wrecking of a single ship. At noon of that day the frigate *Semiramis*, from Toulon, bound for the Crimea with troops, met with a fearful tempest and went to pieces on this dangerous reef, and not a single one of the 743 persons who were on board of her was saved. Ten years before this the Sardinian government had erected, on the small island of Razzoli, a small lighthouse for lighting up the strait and its mouth, and the reef of Lavezzi, which separates them. After the catastrophe, there was anchored on the reef itself a bell-boat—an enormous buoy in the shape of a covered long boat, carrying a bronze bell of 175 pounds weight, surmounted by six mirrors for reflecting the rays of the sun and of the neighboring lighthouses. During a storm, however, this buoy was dashed to pieces against the very rock which it was designed to point out. A like disaster having overtaken a bell-boat which replaced the first one, it was finally decided to erect on the submarine rock a watch-tower of masonry.

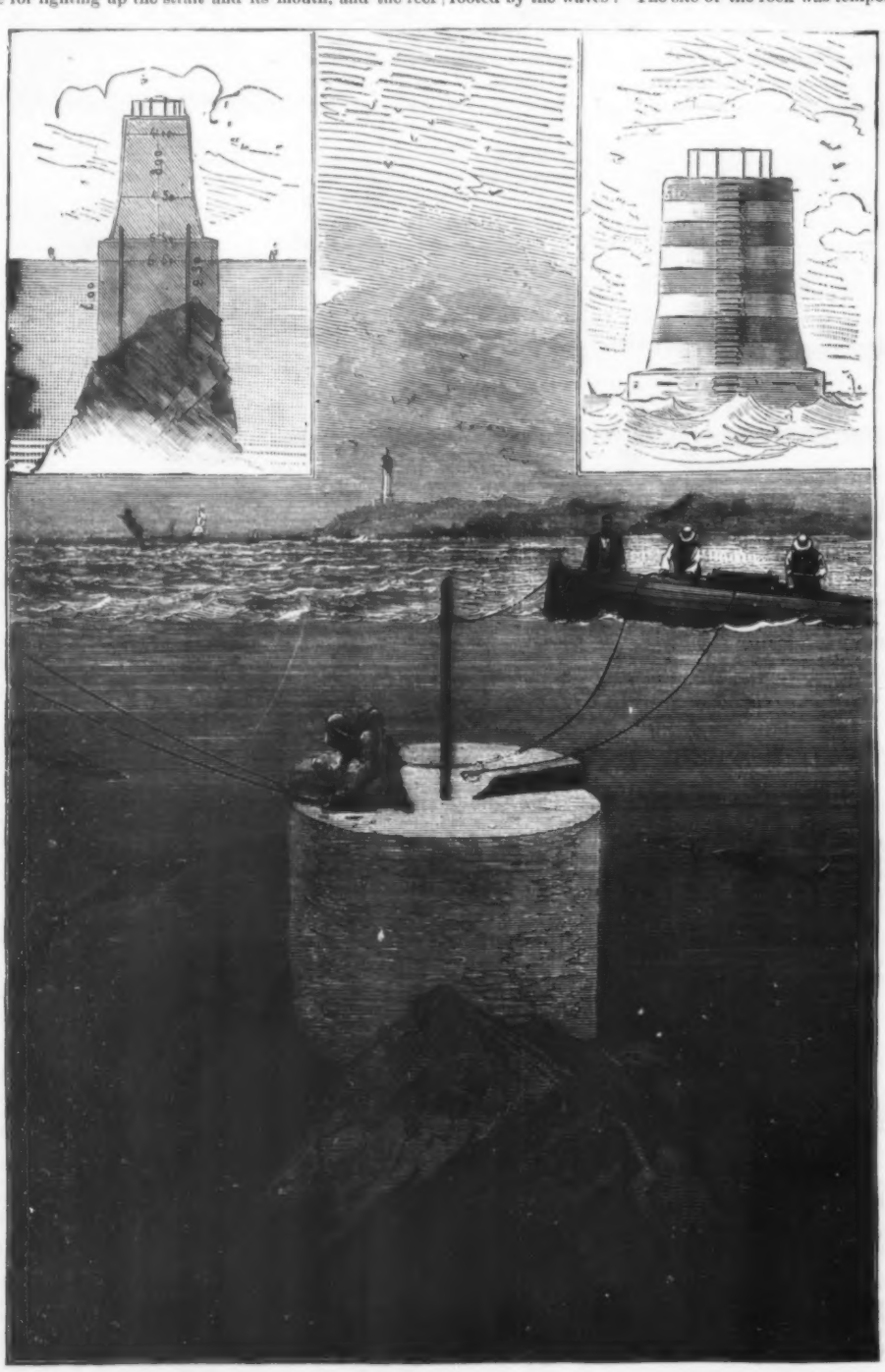
The reef of Lavezzi, situated at the most southerly point of France, in 41° North latitude, is never uncovered, the Mediterranean having no tides. It forms a sort of truncated cylinder of 21·5 feet in diameter, and the least depth of which below the surface of the sea is 7·5 feet, and the greatest, 20 feet. All around this rock, whose upper flat surface is inclined at a steep angle, the depth abruptly increases, and vessels can pass by it in safety. For building on the rock, the caisson system was made use of. In 1869, a caisson having the form and dimensions of the base of the proposed structure, and the unequal height of which had been calculated from the depth of the rock, was sunk on the reef in such a way that its lower part followed the contours of the latter, while its upper portion extended above the level of the water. The interior having been filled with concrete, and a tower erected on this base, it was supposed that the reef was disposed of for good. The tower itself served to mark the position of the reef in the daytime, but some means were needed to show its location at night, inasmuch as the tower was too small to be used as a lighthouse. This object was effected by illuminating it from the lighthouses on the adjacent islands. In 1870, the Italian government succeeded in perfecting a mode of lighting it from the lighthouse of Razzoli: a plate of red glass was fixed in front of lenses in the direction of the tower of Lavezzi in such a way as to project upon the latter rays of red light diverging at an angle of seven degrees. As an addition to this, the French government erected on the southern point of the Isle of Lavezzi a square light-tower, 33 feet high, illuminated by a two-wick coal oil lamp. By means of two colored glasses a ray of green light was thrown towards the north on the reefs which extend between Lavezzi and Corsica, and a ray of red light on the dangerous reef of Lavezzi.

All difficulties seemed to have been conquered forever, when, in 1875, after a storm, it was discovered that the beacon-tower no longer existed, it having been completely uprooted by the waves! The site of the rock was temporarily marked by a buoy, and preparations were at once made for reconstructing the tower. In order to make it forever stable, it was decided this time to secure the masonry to the rock with thirteen iron bars—one of 2·4 inches diameter in the center, four of 4 inches diameter around it penetrating to a depth of 24 inches into the rock, and eight of 6 inches diameter, outside of these and penetrating the rock to a depth of 39·4 inches.

As it was necessary to employ divers to drill the holes in the rock, and as it was impossible for these to remain under water any length of time, on account of the excessive cold, it was decided to build up a foundation of concrete—reserving in the mass twelve main or well holes lined with cast-iron tubing—until having reached a certain height above the water level it should form an artificial isle. Everything needed had to be brought from Marseilles. Barracks for the workmen were erected on the island of Lavezzi, over a mile north of the reef. The preliminary work was begun in April, 1876. On the first of June, forty-six men were collected at Lavezzi, and operations were begun in earnest, but on the third day they were interrupted by a great storm which lasted eighteen days; and this was followed during the summer by eleven successive tempests, so that out of a hundred and seventeen days work could only be performed during thirty-six. Armed with a bronze poniard (steel being easily corroded by sea water) to defend themselves against the attacks of sharks and "devil fishes" which infest this part of the Mediterranean, the diver descended to the rock and spread the concrete, pailful by pailful. The strongest men among them could perform this arduous submarine work only two hours in the morning and two in the evening; for this reason the divers, instead of being paid by the day, received four centimes for every minute spent under water.

At length, on the 30th of September, 1876, the mass of concrete had reached a height of a little over three feet above the surface of the water, and the workmen could now begin to drill the rock through the twelve cast-iron tubes which traversed the mass from top to bottom. The boring was effected by means of steel drills, reaching to the bottom of the well holes, precisely as in the process of driving artesian wells. Into the holes thus made, long iron bars were inserted and carefully cemented, and upon the base thus constructed was erected the tower properly so-called (see section in upper left hand corner). The work was finished on the 14th of September, 1877.

The tower, which is round, rises 23 feet above the level of the sea, and from 30·5 to 43 feet above the rock foundation; the foundation is 21·4 feet in diameter, and the tower 18 feet in diameter at its base and 13 at its summit. The beacon is painted in alternate bands of red and black, thus indicating the fact to seamen that they can pass by in safety on either side. (According to a code known to marines, had it been only safe to pass by to the left, the tower would have been painted black; had it been painted red, with an upper stripe of white, they would have known that they were to go to the right.) The tower is furnished with a ladder, and it is surmounted by a railing, so as to serve as a refuge in case of shipwreck.



CONSTRUCTION OF THE BEACON TOWER OF LAVEZZI IN THE MEDITERRANEAN.

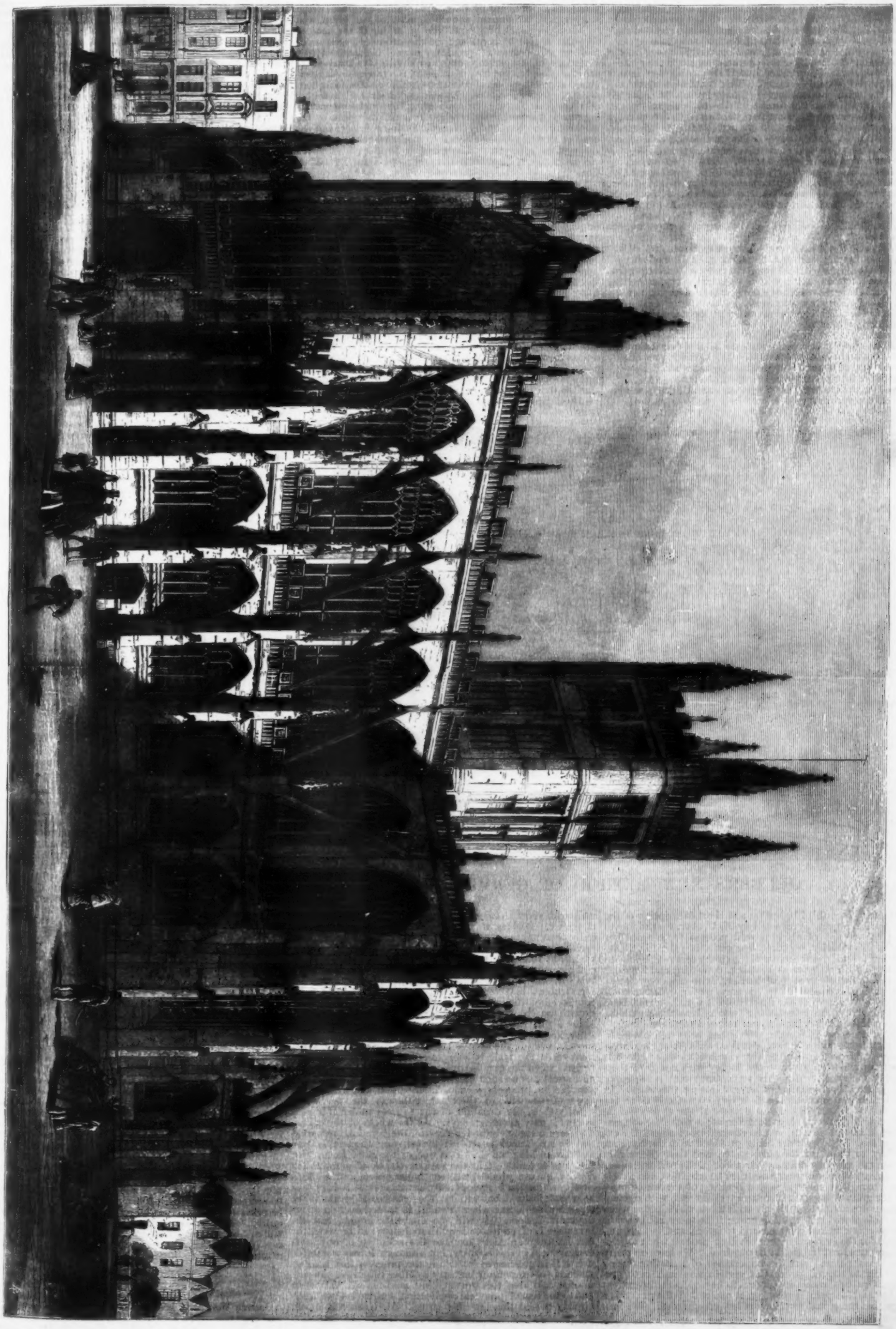
BATH ABBEY CHURCH.

Drawn by Mr. S. Reade.

Bath, one of the fairest and most dignified of provincial cities, though it gives a name, jointly with Wells, to an episcopal diocese, has not usually styled its venerable abbey church a cathedral. There was an ancient abbey of Benedictine monks at Bath. The see of Wells, in Norman times, was removed to Bath, and was afterward revived at Wells, but was ultimately combined with that of Bath, in 1135. The ancient church of the abbey fell into decay in the fifteenth century, till Bishop Oliver King, assisted by the priors, one of whom continued his work, began to construct the present edifice, between 1495 and 1503. The abbey was dissolved, and its cloisters, priory, dormitory, and chapter-house were destroyed in 1539. The abbey church was restored, in Queen Elizabeth's reign, by the munificence of Peter Chapman and Thomas Bellot, aided by Lord Burleigh and the Earl of Sussex, and was completed by Bishop Montague, under James I. The building is cruciform, consisting of a nave, with five bays, a choir, which has four bays, and a transept of two bays, without aisles. The nave is 136 ft. long, 72 ft. wide, and 78 ft. high, with a flat roof of richly paneled wood. The choir is 74 ft. long, with a breadth of 20 ft. only; the combined length of the two transepts is 126 ft. There is a central tower of two stories, 162 ft. high. The clear-story, which is very lofty, with no triforium above it, is the prominent feature of the interior. The roof of the choir and transepts is vaulted, and decorated with intricate fan-tracery, resembling meshes of seaweed. The exterior is, from the narrowness of the street, not seen to advantage on the south side, which is that represented on the next page, but its proportions are imposing, and it has quite the character of a cathedral. Its architectural interest must be confessed to be inferior to that of churches built in the times of the older Gothic styles; notwithstanding which, it deserves to be classed with the old English cathedrals.—*Illus. London News.*

SHOEMAKER'S WAX.

Shoemaker's wax, when made for hand work, is composed generally of equal quantities of pitch and resin, with 10 per cent. of tallow; after boiling (if good wax), it is pulled until the wax assumes the color of pale resin. The pulling takes out, or, more properly, bleaches, the ingredient pitch, and thereby takes out the coloring all pitch contains. Wax used for machines has all of it too much pitch and tar for clean work; the coloring matter in pitch and tar comes up through the grain; once in it cannot be got out—and wax boiled or heated again, unless in a perfectly clean vessel, and even then, partly recovers the coloring bleached out by hand pulling. Wax that will work up the pure bronze color so much liked by shoemakers may be made of 4 lbs. resin, 1 lb. pitch, 4 ozs. beeswax, 3 ozs. tallow—the tallow to be refined, otherwise 3 ozs. best sperm oil. The beeswax seems to destroy the coloring matter of the pitch when in that proportion. A good resin wax is superior to any other composition for wear, because it decomposes on exposure and wear into a stony substance in appearance, and looks not unlike pegs of amber when put under the microscope. Wax, with tar at all in, or much pitch, when heated continuously, becomes only a dirty discoloring matter, as the oil evaporates, carrying with it all the valuable adhesive or glutinous properties of the pitch, and such wax will most readily soil or discolor the flange of the channel that is laid over it. The above recipe makes a wax which will give satisfaction.



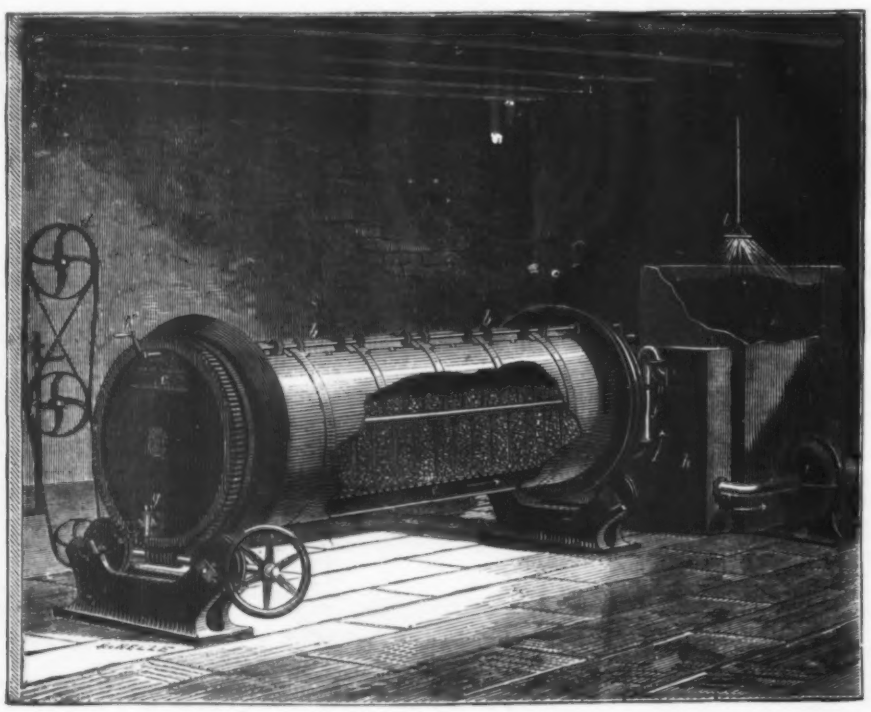
BATH ABBEY CHURCH, ENGLAND.

A NEW METHOD OF GERMINATION.

AMONG the papers read before the International Congress of Brewers at Paris was an important one by M. Gruber, the well known brewer of Königshofen, near Strasbourg, describing his new invention relating to the germination of grain. The new apparatus is intended to conduct and control the process by mechanical appliances, so as to altogether dispense with manual labor in turning the grain over on the germinating floor. By this apparatus an artificial ventilation by means of a current of humid air passing downwards through the grain is effected. This ventilation keeps the mass at a relatively low degree of temperature (54° F. to 56° F.), and at the same time draws off the carbonic acid gas as fast as it is produced. Moreover, the thorough turning over of the grain, and its complete division by the periodical rotation of the cylinder, in which the germination takes place, insure a most regular and uniform development of both rootlets and plumule.

The accompanying illustration serves to give a good idea of this new apparatus. It consists of an iron cylinder, which by means of an endless screw receives a slow rotatory movement. The letters in the drawing refer to the following parts:

b, Longitudinal openings for charging and emptying the apparatus.
b', Handle for opening and closing the above.
c, Sheet iron gratings for admission of moistened air.
d, Mechanical appliances for giving motion to the cylinder.
e, False bottom of perforated sheet iron supporting the grain, and through which the air is drawn downwards.
f, Pipe for drawing out the air.
g, Tap for admitting and drawing off the steep water.
h, Exhaust chest.
i, Fan.
k, Chamber for moistening the air by filtering it through porous substances kept constantly saturated with water.
l, Shower of water on the moistening chamber.
o, Valve for regulating the draught of air.
p, Rake for dividing the layers of grain during the rotation of the cylinder.



GRUBER'S NEW METHOD OF GERMINATION.

Having given this illustration and short description of the mechanical apparatus invented by M. Gruber, we propose to give an account of his improved process for germinating grain. The barley, or other raw grain, is placed in the revolving cylinder, and there undergoes the three steps known to the English maltster as steeping, couching, and flooring; in fact, the whole process of malting, with the exception of kiln drying, is conducted in this germinating cylinder.

For the purposes of our description it will, however, be as well to divide the germinating process into three periods, corresponding to the three stages referred to above.

First Period.—The grain, which has been well screened, is run into the cylinder, where it is completely covered with water. It is well known by the practical maltster that it is most important to saturate the barley with moisture thoroughly and evenly. Another important point is to supply the grain with a quantity of oxygen during this stage. In the ordinary steep cisterns this is very imperfectly done, for the air has access only at the surface of the mass; but in this new invention, it is quite different; a complete oxygenation of the whole mass can be effected by means of the exhaust fan. The cylinder being provided with the tap, *g*, it is easy to draw off the steep water, and then thoroughly aerate the mass by drawing air through the perforations at *c*; a fresh supply of water can then be admitted, and in this way a complete moistening and aerating of the whole mass of the grain is insured. The barley thus meets with circumstances approximating closely with those which occur when a seed is placed in the soil to grow; it is there subjected to the alternate influence of air and moisture, and is thus prepared for the subsequent germinating process when the necessary temperature should be obtained. We have on many occasions pointed out the importance of imitating during malting the natural process of germination, and in this respect Gruber's machine appears to be a valuable invention. A little white point appearing at one end of the grains is a sign that the actual germination has commenced. We then come to the

Second Period.—The grain having been saturated with sufficient moisture to render soluble the substances necessary for the nourishment of the young plant, and having been fully supplied with oxygen, certain changes occur in its interior; the embryo enlarges under the influence of the nutritive juices, the husk bursts, and the young rootlet appears. It is one of the principal objects of the maltster to obtain a uniform commencement of the germinating process. This is only to be obtained by starting and sustaining a uniform temperature throughout the whole mass of the grain, and by submitting each of the millions of grains in the mass to the same degree of aeration. In the ordinary processes of malting this degree of exactness cannot be obtained; the variations of temperature and humidity in the atmosphere are obstacles, but the irregularities of the thickness, temperature, and desiccation of the grain while on the malt floor are still greater obstacles. By the use of Gruber's machine all these obstacles are surmounted. An equal temperature is preserved throughout the whole mass of the grain by the slow rotation occasionally imparted to the cylinder, and the aeration of the grain is effected by the current of air drawn through the apparatus. The grain, in fact, is placed under circumstances best calculated to produce a natural germination.

Third Period.—As the result of the germinating process, the acrospire should be fully and evenly developed, the rootlets should be short and curled, there should be a maximum production of diastase, and the kernel of the grain should be rendered farinaceous and friable. Under the ordinary system of malting, such perfection is difficult if not impossible to attain, and at all events necessitates an enormous space to be used as germinating floors. To regulate the temperature and moisture, the malstster turns the malt over on the floor from time to time. In Gruber's apparatus, on the other hand, a successful result is obtained with certainty. The current of air which is being continually drawn through the cylinder containing the grain, maintains a temperature sufficiently regular and low, and as the air is being continually moistened, the requisite degree of humidity is sustained; in addition, the periodical rotation of the cylinder assists to maintain a uniform temperature throughout the mass; by the aid of the internal rake with which the apparatus is supplied, the mass is scattered about during rotation, so that each grain is independent of its neighbor. The result of this movement of the grain is the production of a malt with short and curled rootlets, and of a very uniform character. Besides, this rotatory movement, which effectually prevents the entanglement of the separate grains with each other, has another advantage: it prevents the rootlets which, in following the universal law of nature, gravitate and descend, from closing up the holes in the false bottom. We will now point out another advantage which is claimed for Gruber's machine: practical maltsters have long been convinced of the importance of having a slow but regular growth on the floor in preference to a hasty one, and to achieve this they, at the expense of considerable manual labor, keep continually turning over the malt by means of shovels, making the process last about a fortnight; these periods when the malt is being scattered by the shovel are periods when the germinating process is suspended. In the new apparatus no such breaks occur, the slow but continual germination proceeds without interruption and without periods of stagnation; therefore, although the process is equally slow, the duration of the process under this new system is only about ten days. As the whole of the operations are completely under control, the germinating period may be lengthened as desired by lowering the temperature and diminishing the air. It is one of the chief features of this new invention, that the various stages of germination can by its use proceed without interruption, and while a slow germination is undoubtedly advantageous, it is by this apparatus insured, but without the detrimental breaks in the process which occur when the malt is turned over on an ordinary malt floor. It will, no doubt, be argued that the invention is of no use to English maltsters and brewers, for our Excise regulations exclude the adoption of any such contrivances in this country, but although it may not be of use, it is interesting as indicating the progress that is being made in this important industry by other countries. It may also be said that this germinating machine will fail when put to the test of practical application, but we believe it has already passed through this ordeal. M. Gruber is a well known brewer, and is himself a practical man; his invention has been fitted up and tried on a manufacturing scale, and we are informed with the best results; he has manufactured by means of it at Königshofen, all the year round, malt of a superior quality; the low and constant temperature at which the germination is conducted has yielded a malt of superior quality, which contains much less acidity than samples prepared in the ordinary way, and the product is one which answers all the requirements of a good and sound malt such as the brewer desires. This invention economizes manual labor, and dispenses with the troublesome process of repeatedly turning over the malt on the floor: it effects an enormous saving in space, both of land and buildings, for a machine six feet in diameter and eighteen feet in length is sufficient to effect the germination of above 30 quarters of grain.

It has been truly said that the maltster is the father of beer, the brewer being only the godfather; if, therefore, such inventions as the one we have now referred to should lead to an improvement in the quality of the malt, the brewer will be the gainer; and we willingly add our words of thanks to M. Gruber and other inventors who are making discoveries and stimulating discovery in this direction.—*Brewers' Guardian.*

IMPROVED PROCESS FOR TREATING WOOD, ETC., FOR PAPER MANUFACTURE.

By DR. A. MITSCHERLICH.

THE process is based upon the action of bisulphite of lime on wood, straw, and other vegetable materials used for the manufacture of pure cellulose for making paper pulp. The bisulphite may be easily made by decomposing the carbonate by means of sulphurous acid. When wood is exposed to the action of a hot solution of bisulphite of lime, all its constituents, with the exception of the cellulose, which is only bleached to a certain degree, will be dissolved, and may be easily separated by washing. The cellulose can now be converted into pulp. It is very white and possesses great tenacity. For very fine white papers, it may yet be bleached by a little chloride of lime, but the use of the latter must be avoided as far as possible, as it always injures the strength, and hence the value of the material. The substances contained in the sulphite solution are worked up into materials for various purposes. When woods or other materials containing tannin are used, the latter substance may be separated and used for tanning. The glucosides can be converted into mucilage, and finally pyro-acetic acid and alcohol may be obtained. In this manner the wood may be entirely used up, and a material of superior quality for the manufacture of paper is obtained at a very low cost.

It may also be remarked that during fermentation the bisulphite of lime may be of great service, as by its use the formation of acetic acid may be entirely prevented. Fermentation may be perfectly controlled by bisulphite of lime and heat, as it is retarded and even actually stopped by the former and accelerated by the latter.—*Chemiker Zeitung.*

BRONZING PLASTER OF PARIS CASTS.

THE casts receive first several coats of a rapidly drying linseed oil varnish. When the surface has been thickly and evenly covered, and the varnish is completely hardened, another coat is given with a varnish composed as follows: Linseed oil varnish, 1 part; copal varnish, 1 part; oil of turpentine, 1-15 part. The copal varnish must be free from alcohol. This varnish will be dry enough in from 18 to 24 hours; the coat must be quite glossy and adhere slightly to the fingers. Powdered gold, silver, or copper bronze is now applied with a soft brush. The surface is then rubbed with cotton wadding, by which a very beautiful finish is imparted to it. The most important point is that the linseed oil varnish is perfectly dry before the other varnish is applied, and the latter must be of the proper consistence before bronzing it.—*Chem. Zeitung.*

SAL SODA FOR UNHAIRING HIDES AND SKINS is used in connection with lime and sulphur. The particular merit of the soda lies in the readiness with which it removes all grease from the hides, but, used alone, its action would be too severe, and sulphur is employed to counteract this. For a pack of fifty hides, slake eighty pounds of stone lime, and with the thick paste which this yields knead thoroughly ten pounds each of soda ash and pulverized sulphur, mixing with only a small portion of the lime at first, but completing the mixture while the lime is yet warm; to this add lime liquor, mixing thoroughly, and then pour into the vat and plunge the whole. No more liquor should be in the vat than sufficient to cover the hides when thrown in. The lime should be kept up to summer heat, and the stock should be handled at least once or twice a day.

SIEBURGER'S PASTE.—Soak four parts, by weight, of glue, in 15 parts of water, and warm slowly until a perfect solution is formed; then dilute with 65 parts boiling water, stirring thoroughly. Take 30 parts of starch, stirred into 200 parts of cold water, and free from lumps, and into this pour the glue solution, heating and stirring. If the paste is to be kept add ten drops of carbolic acid.

TO TAN LACE LEATHER WITH SOFT SOAP.

THE skin or pelt should be unhaired with lime in the usual way, and, after the hair is removed, the pelt should be freed from lime as much as possible. This can be done with warm water or the ordinary bates. When thus prepared the pelt is immersed in soft soap and frequently handled, just as in tan liquor. The soap should be kept up to the usual strength, otherwise the pelt will perish. Indeed, there should be rather an excess of alkali over the grease always maintained. The ordinary soft soap bought in stores is not strong enough; but strong country-made soft soap will tan or taw the pelt in a few days. After the pelt is struck through, it should be scraped off and dried; when dry, or nearly so, it should be *mooned* until soft. No oil or other finishing will be required. This process will make tough lace leather, that will not become tender by age, and it is withal a cheap process. Its excellence has been tested by some of the best manufacturers in the country.

NICKEL COMPASS NEEDLES.

JOSEPH WHARTON has sent to the French Academy a marine compass with a nickel needle, constructed nearly after Sir William Thomson's model. Four similar compasses have been placed on Russian cruisers. It is proposed that the fifth should be put on a French ship for comparison with steel needles.—*Comptes Rendus.*

PRACTICAL DYEING RECIPES.

THE following practical recipes, says the *Textile Colorist*, are verified as reliable, and warranted to come out satisfactorily, provided the proportions are strictly adhered to, and the manipulation be workmanlike:

RECIPE No. 1.—BLUE WHITE ZEPHYR.

100 lbs. zephyr.
Boil 8 lbs. neutral soap.
Add through filterer 3½ lbs. indigo carmine (neutral).
½ oz. methyl purple, 5 B (Pickhardt & Kuttroff).
Enter the yarn, without washing, from scour-box at 115° to 120° F. Give four to five turns, whiz well and bleach with 5 lbs. sulphur.
Note 1.—To procure bright and clean shades it is very desirable to take all the foam off the liquor; also to pass a few hanks of yarn before entering the lot.
2.—Unevenness of color is a proof of want of soap.
3.—This liquor once started is strong enough for another 100 lbs. of yarn, without additional dye stuff.
4.—By quick drying a more decided purple cast will be produced.

RECIPE No. 2.—SCOTCH BLUE ON WORSTED.—ONE BATH.

50 lbs. worsted.
Dissolve 10 lbs. Glauber salts.
5 lbs. alum.
¼ lb. red tartar.
½ gallon sulphuric acid.
20 lbs. indigo paste (medium quality).
3 lbs. archil carmine (Pickhardt & Kuttroff).
Enter the yarn at 180° F., give eight turns, bring to boiling, then give about six turns, whiz well and dry.
Note 1.—To get the shade even it is advisable to begin with 15 lbs. indigo paste, and 2½ lbs. archil, add balance when boiling.
2.—In using common or medium indigo paste, it is advisable to add sulphuric acid after dissolving all other drugs, then skim the liquor from the impurities which rise to the top.
3.—Should the shade turn to red, 1 pint sulphuric acid will reduce the same. ¼ oz. methyl purple, or a finer quality of indigo paste, will produce more brightness of color.

RECIPE No. 3.—SCOTCH GREEN ON WORSTED.—ONE BATH.

50 lbs. worsted.
Dissolve 10 lbs. Glauber salts.
5 lbs. alum.
½ lb. red tartar.
20 lbs. indigo paste.
4 oz. picric acid.
½ gallon sulphuric acid.
Proceed the same with drugs as recipe No. 2, Scotch blue.

RECIPE No. 4.—JACQUINEAUX ON WORSTED.

50 lbs. worsted.
Prepare 2 lbs. alum.
4 lbs. Glauber salts.
2 oz. fast red, R } (Pickhardt & Kuttroff.)
2 oz. " " RRR }
Enter at 150° F., turn continually, and raise to boiling, which will produce scarlet shade.
Second bath, 4 oz. fuchsine.
½ lb. archil carmine (Pickhardt & Kuttroff).
Enter at 150° F., raise to 200° F.
Note 1.—In the first bath it is liable to turn uneven, but by careful working and quick turning, it can be avoided.
2.—This is a valuable substitute for cochineal.

RECIPE No. 5.—DRAB ON WORSTED.—ONE BATH.

100 lbs. worsted.
Boil 5 lbs. alum.
5 lbs. Glauber salts.
Then add 3 lbs. extract of indigo.
1½ lbs. archil.
1 oz. picric acid.
¼ oz. blue violet, BB (E. Sehlbach & Co.).
Enter the yarn at 160° F., give six turns, bring to boiling heat, and boil about half hour, give six turns, whiz well and dry.
Note 1.—If the water is cloudy use about four oz. oxalic acid, and skim the same before using dye stuffs.
2.—This will be fashionable for spring and summer wear.

RECIPE No. 6.—GOLD ON VENETIAN CARPET YARN.—ONE BATH

80 lbs. yarn.
Dissolve 4 lbs. oxalic acid.
2 lbs. tin crystal.
½ lb. tin solution or yellow mordant.
1 lb. flavine.
6 oz. cochineal.
This vat has to be cleansed by ¼ lb. oxymuriate of tin, at 120° F., a thick mass will come to the surface and has to be carefully skimmed, otherwise the color would not be bright.
Enter yarn at 160° F., turn continually to boiling heat, to shade desired.
Note 1.—A more decided yellow tint can be produced by adding more yellow mordant; caution must be observed not to exceed the use of it, as the yarn will be harsh.
2.—Where the water contains lime, a small quantity of crystal tartar will be beneficial to make the yarn more even and soft.

RECIPE No. 7.—RED BROWN SLUBBING.

100 lbs. slubbing.
Prepare 2½ lbs. tartar.
2½ lbs. alum.
2 lbs. chrome.
Bring to a boil for one hour, wash and enter second bath.
Second bath, 50 lbs. hypernic.
5 lbs. fustic.
Note 1.—Darker shade requires 2 lbs. logwood chips additional.
2.—Heavier shade will be produced by finishing next day.
3.—If too much alum is used, the mordant will be too strong to fix color fast.

RECIPE No. 8.—SCARLET BRAID.—ONE BATH.

100 lbs. braid.
Dissolve 5 lbs. oxalic acid.
2½ lbs. tin crystal.
6½ lbs. cochineal.
6 oz. flavine.
Enter at 180° F., and boil for one hour, giving eight turns in that time.
Note 1.—Braids ought to be always well scoured, warm washed to avoid dark spots.
2.—Observe the same in reference to water as in recipe No. 6, note 2.

RECIPE No. 9.—SLATE BRAID.—ONE BATH.

100 lbs. braid.
Cleanse the vat with 2 lbs. alum.
Add 10 lbs. alum.
10 lbs. Glauber salts.
1 lb. red tartar.
4 lbs. indigo paste.
2 lbs. archil carmine (Pickhardt & Kuttroff).
1 oz. picric acid.
½ gallon sulphuric acid.
Commence with 3 lbs. indigo paste.
1½ lbs. archil carmine.
¾ oz. picric acid.
Enter at 180° F., give it six turns, then add balance of drugs, bring to boil, and give six turns to shade, dry slowly.
Note.—For a fresh vat, 20 lbs. alum, 20 lbs. Glauber salts, and 1 gallon sulphuric acid will be required.

RECIPE No. 10.—LIGHT DRAB ON COTTON.

60 lbs. cotton yarn.
Boil 3 lbs. sumac.
1 lb. logwood chips.
1 lb. fustic.
Enter the yarn at 120° F., give five turns, wring, add 4 oz. copperas, give five turns at the same temperature, take out and add
4 oz. nitrate of iron.
½ bucket fustic liquor.
Give five turns and wash out in water.
Second bath, 2 lbs. soap at 110° F., give five turns and wring.
Note 1.—This shade will stand fulling, and will be fashionable for spring and summer of 1879.
2.—Fustic liquor is made, 36 lbs. of fustic to eight buckets of water.

RECIPE No. 11.—BLUE ON COTTON.

100 lbs. cotton yarn.
Prepare with 8 lbs. alum.
8 oz. tartaric acid.
4 lbs. sal soda.
14 oz. aniline cotton blue, BB (Lutz & Movius).
Enter hot, turn for twenty minutes, take out, raise temperature to boiling, re-enter and turn to shade.
Note.—For second lot of 100 lbs., cotton yarn, use 6 lbs. alum, 6 oz. tartaric acid, 3 lbs. sal soda, and 10 oz. blue, BB.

RECIPE No. 12.—BROWN ON COTTON

60 lbs. cotton yarn.
Prepare with 14 lbs. cutch.
14 oz. blue vitriol.
Give three turns and leave the cotton in this solution over night, next take out and wring well.
Second bath, 4½ lbs. bichromate of potash.
Enter boiling, give four turns; wring and re-enter into the old cutch bath again; give four turns, wring well, and enter chrome bath again; give four turns, wring again, now add to cutch bath
5 lbs. logwood extract.
Give six turns, and wring out and enter.
Third bath, 4 lbs. copperas, cold.
Wring, re-enter old chrome bath, give four turns, wring and finish with—
1½ lbs. alum.
3 buckets boiled logwood chips liquor.
1 bucket hypernic liquor.
And turn to shade.
Note 1.—*The logwood chips liquor* is 24 lbs. of logwood chips to eight buckets of water.
2.—*The hypernic liquor* is 36 lbs. of hypernic to eight buckets of water.
3.—This is a superior brown on cotton, and although a great amount of labor, is one which is very desirable.

CHROME ORANGE ON COTTON CARPET YARN.

100 lbs. of yarn.
16 lbs. of brown sugar of lead.
8 lbs. of litharge.
8 lbs. of chrome.
5 lbs. of lime.
1 Bath.—Dissolve the lead and litharge, enter the yarn, which must be previously boiled out, give five turns, wring out.
2 Bath.—Dissolve chrome, enter yarn warm, give the necessary turns, from three to five, wash off and wring
3 Bath.—Slake the lime, enter the yarn boiling hot, and turn to finish, wash off and wring ready for the drying room.
Note 1.—For finer yarns, white sugar of lead will work a cleaner or brighter color, but not as heavy a body.
2.—If the color should not be red enough in liming, throw up and add more lime.

BLACK ON COMMON MIXED CARPET YARN FOR FILLING.

100 lbs. yarn.
Prepare 25 lbs. extract of logwood.
8 lbs. blue vitriol.
8 lbs. sal soda.
Boil up, enter yarn, give three turns slowly, take up, wash, and it is finished.
Note 1.—The second 100 lbs. requires only 15 lbs. extract of logwood, 6 lbs. of blue vitriol, and 6 lbs. sal soda.
2.—The third 100 lbs. requires only 10 lbs. extract of logwood, 4 lbs. blue vitriol, and 4 lbs. of sal soda, and keep it for future use.
3.—This is a fair black, and size may be worked with it.

BLACK ON COTTON AND WOOL MIXED YARN.

100 lbs. mixed yarn.
Prepare 42 lbs. logwood chips.
5 lbs. copperas.
5 oz. blue vitriol.
2 lbs. lime.
First take through copperas, then through lime, and finish with logwood.

SOME FACTS IN REGARD TO TELESCOPIC AND STEREOSCOPIC VISION.

By H. FARRAND, C.E.

IT is generally, if not universally, supposed that the sole effect produced by the telescope is to magnify the appearance of objects, and at the same time causing them to appear nearer to the observer. By all those who entertain this supposition, the statement that the telescope magnifies but two of the dimensions of space, and diminishes the third, will be received with some degree of surprise. That such is the case can not only be proved to be the necessary result of the laws of optics, but can easily be perceived in any telescopic view by any careful observer.

Of the three dimensions of space, two can always be supposed to lie in a plane at right angles to the line of sight, or axis of the instrument.

It is obvious that the enlargement of the visual angle by the lenses of the instrument, by which the apparent magnitude of the object is increased, can only be lateral in its direction of operation, and therefore can only affect those dimensions that extend laterally to the line sight, and that the third dimension that coincides with it will not be enlarged by it.

But not only is the third dimension not magnified by the instrumental enlargement of the visual angle, but it is actually diminished by a secondary effect of the same. For the object observed appears to be brought nearer to the observer. The distance between the observer and the object is diminished, or in other words, the dimension of space that coincides with the direction of that distance is diminished. But not only is the apparent distance of objects from the observer diminished, but the distance between objects themselves is diminished, when the direction of that distance coincides with the direction of their distance from the observer. At the same time the distance between objects, when the direction of that distance is lateral to, or crosses the line of sight, will be affected by the enlargement of the visual angle, and consequently will be magnified.

It follows, then, that if in a telescopic field of view one set of distances is diminished and another set is enlarged, objects in that field of view will not appear to occupy their true or natural position with reference to each other.

And what is true in regard to different objects must be true in regard to the different parts of the same object. For the dimensions of an object are only the distances between its several parts.

And for the same reason that different objects will appear to be misplaced in regard to each other, different parts of the same object will appear to be misplaced, and the object itself will appear to be distorted in shape.

We find, then, not only enlargement but displacement and distortion are characteristic of telescopic vision. And as has been remarked, these effects can be observed in every telescopic field of view.

The distance between the farther and nearer boundaries of fields and horizontal spaces appears diminished, and they seem to be narrower in the direction of the line of light.

A horizontal square appears an oblong parallelogram, and a circle in a similar position seems an oval, the shorter diameter in each case coinciding with the line of sight. A sphere appears flattened and more or less discoidal, according to the power of the instrument. A right angle will appear obtuse or acute according to its position with reference to the line of sight.

Let a telescope be directed at the corner of a building, in such a manner that the side and end of the building can both be seen, the obtuse appearance of the rectangular corner will be very obvious.

Another effect of the same optical law is, that all motion toward or from the observer appears to be retarded. If an approaching or receding object, a horse or man, in rapid motion be thus observed, the curious phenomenon will be presented of an object exhibiting all the appearance of rapid locomotion, but without corresponding progress.

If now the telescope be reversed and the eye applied to the larger end, in the field of view thus presented the effects produced by the instrument will be exactly the opposite of those produced in the direct view. The two dimensions of space at right angles to the line of sight will be diminished, and the third dimension, coinciding with the line of sight, will be increased. Objects will appear diminished in magnitude and thrown back in the distance, and distant objects will be lost in the infinite background. At the same time objects outside of the ordinary field of view will be drawn in and appear in the reversed field.

Displacement in position and distortion in shape characterize the reversed view, but contrary in direction to that of the direct view. In the direct telescopic view the displacement and distortion are caused by the diminished perspective, in the reverse view by exaggerated perspective.

In the reversed view, a square or circle lying in a plane approximating to the line of sight will be elongated in that direction.

Angles, when the line of sight crosses both legs, either actually or produced, will be rendered more obtuse; when this is not the case will appear more acute, and motion toward or from the observer will appear to be accelerated.

If the optical image of the reversed view, that is formed on the retina of the eye, could be thrown upon a sensitive plate or paper and photographed, we should have a picture containing all the peculiarities of the reversed view.

Now, it is a fact, that all photographic views, when the picture is reduced in size from the original, contain and exhibit all the peculiarities of the reversed view. Especially is this the case in a stereoscopic view where the exaggerated perspective is brought out by the instrument.

It remains to be remarked, that it is somewhat curious that these facts in regard to telescopic and stereoscopic vision, should not have been long ago recognized; that what is constantly and universally apparent should not have been noticed and remarked.

DAMAR VARNISH FOR NEGATIVES.

A SOLUTION of ten parts of gum damar in one hundred parts of benzine makes a very good varnish for negatives. It is completely colorless, very free flowing, can be easily poured on, can be used cold (if used warm it attacks the collodion film), dries quickly, and makes at least so much solidity as not to offer any resistance to an intensifier. I consider this varnish particularly fitted for those negatives which could usually be varnished with a hard varnish; for example, a solution of shellac in alcohol, retouched with a lead pencil and again varnished to protect the retouching. There is but one trouble in the preparation of this varnish, even if the benzine is warmed to the boiling point, the damar is not completely soluble. The varnish is milky, very

opaque. To be used it must be filtered, which is very tedious and accompanied with loss of benzine.

But the part of the gum insoluble in the benzine I have found to be easily soluble in absolute alcohol and soluble in strong spirits, such as is used for dissolving shellac. If 12–15 per cent. of absolute alcohol, one obtains, after shaking and without removing from the heat, a complete solution of the gum, which for a while appears slightly milky, but after standing thirty-six hours, without the necessity of filtering, becomes clear.

The part of the gum damar insoluble in the benzine appears to be harder; so by the addition of the alcohol, the damar varnish becomes tougher. It should be made after the following formula:

Gum damar (powdered)	10 parts.
Benzine	100 "
Absolute alcohol	12–15 "

Alcohol of the usual strength, nearly absolute, I would not advise the use of, on this ground: The alcohol, with a part of the benzine, forms a resinous solution, which being heavier, separates from the rest of the benzine, and must be removed before used. This is avoided by the use of absolute alcohol.—*Ph. Rust, in Pract. Photographer.*

TO MAKE VIGNETTERS BY MEANS OF GELATINO-CHROMATE.

By Dr. J. Schnauss.*

There are so many different kinds of vignetters now offered for sale by dealers, that I was induced to try and prepare some for my own use, and by the following method I succeeded in obtaining what I required:

From a good positive in black or some non-actinic color a number of negatives of different sizes are taken, but in doing this the image on the ground glass plate must not be focused too sharply. Or, where suitable vignettes are already at hand, the negatives can be taken from them directly by any convenient method; either a collodion emulsion may be used, or chromated gelatine, as described below. To prepare the latter a solution is made of five parts pure white gelatine in sixty parts of water, to which two parts of ammonium bichromate are added, and, when the film is afterward to be drawn off, a few drops of glycerine may be introduced to make it less brittle.

After filtering this solution, pour it, while still hot and fluid, on a well cleaned glass plate; care must be taken to have this plate placed in a perfectly horizontal position, which is best effected by resting it on a larger plate that has already been carefully leveled. The gelatine solution must not be allowed to run over the sides of the plate, or the film may turn out to be too thin; to prevent this give the plate a raised edging of wax. When the chromated gelatine has set, let the plate dry completely in a dark and moderately warm room. Artificial heat should not be used in drying, especially when the film is afterward to be drawn off; when this is the case, the plate should first be rubbed over with powdered talc or diluted ox-gall, and then, on heating, the film easily flies off.

On plates prepared in this way the negatives are now copied, and that as intensely as possible by a long exposure. The copies cannot be too intense, provided that the negatives are quite black in the center of the aperture. When they have been sufficiently exposed, wash them several times in cold water, and, finally, with distilled water; then plunge them, while still wet, into a solution of one part lunar caustic in fourteen parts water acidulated with one part acetic acid.

It will now be seen that the film is coated with a precipitate of silver chromate, which is in the highest degree non-actinic, and is much denser toward the side of the plate. Should there be a trace of chromium salt left, as is often the case, it is of no importance; on the contrary, when really intense vignetters are required, it is not necessary to thoroughly wash out the chromium salt. But, in order to obtain the requisite transparency in the center of the plate, the whole of the silver nitrate must first be washed out, and then a soft and strong hair brush dipped in dilute nitric acid. This is passed over the plate with a few rapid strokes in a circular direction from the center outward up to the commencement of the shading, and the plate is then quickly rinsed. With a little skill a great variety of effects may be obtained in this way, and any required degree of shading.

After drying, the film is coated with a little castor oil collodion, and then, if it be desired to draw it off, with a hot twenty per cent. solution of gelatine to which a small quantity of glycerine has been added. The plate must be laid horizontal, and the addition of a little alcohol to the solution facilitates its flowing. When the gelatine is set, the plate is placed for a couple of days to dry, and it is again coated with some thin collodion: the edges are then cut through, and the film is drawn off.

THE CENTENARY OF THE BIRTH OF SIR HUMPHRY DAVY, DECEMBER 17, 1878.

The day for passing eulogiums on Sir Humphry Davy has long since passed away. His name is known and honored wherever science has penetrated or is penetrating. The reputation of Davy is spreading co-equally with the march of civilization, and the white-turbaned softas of the Dar-ul-Founoun of Mohammedan Stamboul, the dusky students of the University of Brahman Benares, and the pigtailed votaries of the Imperial College at Buddhist Tokio are as rapidly becoming acquainted with the scientific achievements of the Cornish apothecary's apprentice as their more civilized fellow-workers on the banks of the Thames, the Seine, and the Spree. His fame is indissolubly united with substances and principles which lie at the very foundation of chemical theory and practice, and it would be as hopeless a task to attempt to separate the remembrance of his name from those little words, potassium and sodium, chlorine and boron, as it would be to endeavor to deprive matter of molecular motion, or iron of its coercitive force.

Instead, then, of celebrating the centenary of his birth by a string of laudatory platitudes or eulogistic commonplaces, we prefer to hold up his life and labors to the example of those of the rising generation of chemical students who desire to follow in his footsteps. It is not every one who has the desire or leisure, or, indeed, patience, to read through the diffuse biographies of this great man, which were published a short time after his death by his brother, Dr. John Davy, and his attached friend, Dr. John Ayrton Paris, or try to come at the facts of his life among the flowery periods of the *éloge* which Baron Cuvier pronounced before the French Academy of Sciences on the occasion of his death. We think, therefore, it will not be out of place or season if we present our younger readers, at any rate, with a brief sketch of his career from his birth on the beautiful shores of Mount's Bay to his death on the no less lovely banks of Lake Leman.

Before doing so, we would remark that one of the most prominent features in Davy's character was *thoroughness*. Whatever we find him doing, whether it is making fireworks in his guardian's kitchen while yet a child, studying medicine and pharmacy under Dr. Borlase, fly fishing for trout in Scotch or Carinthian lakes, or trying to split up potash and boracic acid into their constituent elements, we always find his distinguishing characteristic to be *thoroughness*. The voluminous collection of notebooks which he left behind him are curiosities in this respect. Observations of every kind and sort are included in these pages. At one time he notes down a peculiarity of flight in a swallow, at another, a philosophical or theological puzzle, at another, the anomalous behavior of certain reagents, with a view to further investigation. Whatever, in fact, he observes, down it goes for future reference or consideration. Even when on what he thought was his dying bed he kept his brother John fully employed either in reading over to him the MS. of his "Last Days of a Philosopher," or, when too ill to listen to him, in dissecting torpedoes in the adjoining room. Whether he shot, or fished, investigated the secrets of nature, or engaged in controversy with obstinate or ungenerous opponents, he worked with all the intellectual might of his wonderful mind, with all physical strength of his hardy body.

Humphry Davy was the eldest son of Robert and Grace Davy, and was born at Penzance, on December 17, 1778. He was a strong, active, healthy child, with a very retentive memory. At six years old he was sent to a small reading and writing school at Penzance, but progressed so rapidly, that his master, very disinterestedly, had him transferred to the town grammar school, which was presided over by the Rev. Mr. Coryton. The grammar school did not seem to have done him much good, as the principal was alternately indulgent and cruel, strict and careless. When he was nine years old he was taken charge of by a Mr. Tonkin, a friend of his mother's family, to whom she and her sisters were indebted for a father's care after the death of their parent.

Mr. Tonkin lived at Varfell, a small village situated in a beautiful part of Mount's Bay, and it was evidently during this period that he acquired that ardent love of the beauties of nature and of open air sports which were one of the chief pleasures of his happy life. In the intervals of study under Mr. Tonkin he was riding, fishing, shooting, gardening, or collecting and painting specimens of natural history or minerals; in fact, he does not seem to have worked very hard at his books during this period, and at one time appeared likely to grow into a sporting naturalist instead of a philosopher.

When he was in his sixteenth year his father died, a sad event which seems to have had a great effect on him. He at once applied himself seriously to study, and on February 10, 1794, when only a few weeks over fifteen, he was apprenticed to Mr., afterward Dr., Bingham Borlase, surgeon and apothecary, of Penzance. His notebooks of the period show the ardor with which he began his work under Dr. Borlase. He drew up for himself an impossible course of study, comprehending almost every branch of knowledge, including the acquirement of no less than seven languages, his own profession, however, claiming the major portion of his time. His first MSS. now begin to appear, and, like those of many a clever youth of his age, were on theological, ethical, philosophical, and political subjects. He thus early showed the bias of his mind, and these fugitive productions, although boyish and incomplete, nevertheless contain the germs of the thoughts which at the close of his life he so eloquently expressed in the "Salmonia" and the "Consolations of Travel."

He also began to write poetry, *tant bien que mal*, a practice which he seems to have kept up almost to the day of his death. Samuel Taylor Coleridge said that if he had not been the greatest English chemist he would have been the greatest English poet, an opinion in which few critics will join. His verse is mellifluous, and the thoughts he intends to convey are always of a noble character, but the divine *afflatus* is entirely wanting.

In 1796 he took up the study of mathematics, and went through a severe twelve months' course, thus evidently laying the foundation of that singularly exact and acute style of reasoning which he employed with such ability and success in upholding the elementary nature of chlorine against a cloud of opponents all fully worthy of his steel. In 1796 he began to study the Scotch metaphysicians, as well as Kant, and the Transcendentalists, but it was not until the following year, when he had just passed his nineteenth birthday, that he took up physical science as a study. By the end of the year he added chemistry, using the works of Lavoisier and Nicholson.

Like many another poor student, he converted his bedroom into a laboratory, and thoroughly examined the materials he met with in his everyday work by the aid of a collection of vials, teacups, and tobacco pipes, adjourning to Mr. Tonkin's kitchen whenever he had any crucible operations to perform. In 1797 he began to write his "Researches on Light and Heat," published a couple of years after, which attracted the attention of Dr. Beddoes, of Bristol, with whom he entered into a long correspondence, which ended in his converting the learned doctor to his views. He was now pursuing his profession with the greatest perseverance, receiving the most valuable assistance, in a scientific sense, from his intimate intercourse with Mr. Gregory Watt, the son of the great James Watt, and with Mr. Davies Gilbert, who was his senior by some years and well versed in the science of the day. With these companions he used to ransack the country for miles round for specimens of minerals, rocks, and fossils. He was also assisted greatly by being allowed to use two excellent libraries, one belonging to his master, the other to the Rev. Dr. Tonkin, the eldest brother of his friend and guardian.

Toward the end of the fourth year of his apprenticeship he received a proposal from Dr. Beddoes, at Bristol, to take charge of a newly founded institution, called the Pneumatic Hospital, in which every ailment under the sun was to be cured by the inhalation of gases and vapors. He joyfully accepted this offer, for he had been thoroughly fascinated by experimental research, and Dr. Beddoes' institution was provided with a well appointed laboratory. After working for a year, presumably under Dr. Beddoes' direction, he set up a private laboratory at his house at Clifton, which was the beginning of his independent researches. He now began the systematic study of all the then known gases, and their physiological effects on the human frame. He also took up the study of the infant science of voltaic electricity, but his great research at this time was that which ended in the discovery of nitrous oxide.

This was the turning point of his career, and the fame of young Davy's discovery spread everywhere. While at Bristol, too, he seems first to have suspected the compound nature of hydrochloric, hydrofluoric, and boracic acids. He even tried to decompose certain metallic chlorides by passing the vapor of sulphur over them at a red heat, but without success. He also tried to decompose hydrochloric acid gas by means of the electric spark, but also failed. One of his experiments nearly proved fatal. During some researches on the physiological effects of carbureted hydrogen he inhaled too large a quantity of the poisonous gas, and became so ill from the effects of it that he had to relinquish work for a time.

In 1801 he received a communication from Count Rumford, the founder of the Royal Institution, offering him the post of assistant chemical lecturer, with the right of succeeding Dr. Garnett as principal chemical lecturer whenever that gentleman, who was growing too old for the post, should think fit to retire, an event which happened in the year following. He consequently resigned his position at Bristol in February, 1801, and delivered his first lecture at the Royal Institution in the April following, in the presence of Sir Joseph Banks, Count Rumford, and all the scientific and literary celebrities of the day. He seems to have taken his audience completely by storm. His manner, his personal appearance, his intelligent countenance and sparkling eyes, his youth and simplicity, as well as his happy illustrations and well chosen experiments, made him the pet of the hour, and Davy's Royal Institution Lectures soon became as fashionable as Almack's or the Ancient Concerts. His great reason for quitting his friend Dr. Beddoes, to whom he seems to have been much attached, was his passion for research, Count Rumford having promised him the sole and uncontrolled use of the laboratory and apparatus of the institution.

He began at once by continuing the voltaic researches he had commenced at Bristol, an account of which he had published in *Nicholson's Journal*. Invitations to dinners, balls, and soirées now began to pour in upon him, and the handsome, well bred philosopher became the rage. During his stay at the Royal Institution he seems to have seldom burned the midnight oil. He worked hard during the day, and devoted the evening to social intercourse with the aristocracy of birth and brain, with all the thoroughness of his nature. During the recesses he used to rush off to Wales, Scotland, or to any other part of Great Britain where his beloved trout could be found. He explored most parts of England in this way, always, however, bringing back with him well filled cases of mineralogical, geological, and rock specimens. The chemistry of agriculture at this time greatly engaged his attention, and in 1802–3 he gave a series of lectures on the subject at the request of the Board of Agriculture, which were afterward published, in 1813, under the title of the "Elements of the Chemistry of Agriculture."

Among his first work at the Royal Institution was a series of researches into the properties of catechu as a tanning material, but voltaic electricity and electro-chemical science, as well as the analysis of rocks and minerals in relation to geology and agriculture, took up most of his time. But the day was fast approaching when he was to make his indelible mark on the chemistry of his own and all future time.

His first Bakerian Lecture was delivered in November, 1806, in which he laid down the laws of electricity in relation to chemical combination; his second Bakerian Lecture, in the following November, giving in the results of the application of these laws the amplest confirmation of their truth. His career for the next six years was a simple triumphal march of discovery. His papers on numerous subjects, each containing a crop of new discoveries, flowed into the Royal Society's archives in an uninterrupted stream, and it may be said, without exaggeration, that his work during the six years from 1806 to 1812 did more for chemistry than the sixty which followed them. There has hardly been a single discovery made during the last sixty or seventy years which is not in some way or other the more or less direct consequence of Davy's work during this time. These discoveries are too well known to need recapitulation here; they are to be found in the first hundred pages of every half-crown chemical text book.

In 1810 and 1811 his fame spread to Ireland, and he was invited to Dublin to give two courses of lectures in those years. He received 400 guineas for the first course, and 700 guineas for the second. In the last named year he had a strange fancy for continuing his medical studies, and even kept terms at Cambridge in preparation for taking his degree, but science after all had too many charms for him, and he relinquished his intention. Oddly, enough, too, some of his influential friends tried to persuade him to enter the church, promising him speedy preferment, but he declined. In 1812 he married a widowed lady of amp e fortune, a Mrs. Appreece, with whose charms of body and mind he was greatly enamored. A few days before his marriage he was knighted by the Prince Regent at a levée. Immediately after his marriage he resigned his position at the Royal Institution, and, although he was elected honorary lecturer, he announced his intention of giving no more routine lectures.

He considered, no doubt, that he had done enough drudgery, and that the discoveries he had made were sufficient to prevent his being considered a *dilettante* if for the future he followed up only those special lines of research which he had long before laid out for himself. Henceforth he was no longer a paid servant, but a willing volunteer fighting for the glory and advancement of science.

We may mention, *en passant*, that after the delivery of his greatest Bakerian Lecture—the second, in which he announced the discovery of the elements potassium and sodium—he utterly broke down from over-excitement and hard work. He was seized with a feverish attack that seriously threatened his life in 1807, and did not resume work until the following March, when he commenced a series of lectures on electro-chemical science.

Shortly after his marriage he published his "Elements of Chemical Philosophy," dedicated to his wife, which was immediately translated into half a dozen continental languages.

In March, 1813, Sir Humphry Davy appointed Michael Faraday assistant in the laboratory of the Royal Institution, and in the following year took him abroad with him as his amanuensis.

From this time forward his life was one happy round of travel in England and on the Continent, always accompanied by his gun and his book of flies; balls, parties, and court receptions, and occasional brilliant scientific discoveries. The year following his marriage, while experimenting on nitrogen trichloride in his friend Mr. Children's laboratory at Tunbridge, he met with a serious accident, which at one time threatened to destroy his sight. In 1813 we find

* *Photographisches Archiv.*

him hard at work trying to decompose the fluorides, his labors resulting in the discovery of hydrofluoric, silicofluoric, and fluoboric acids. In 1813 he visited the Continent for the second time, passing through Paris, where he proved to the whole of the French Academy that iodine was an element.

The April following found him at Florence investigating the nature of the diamond, which he proved to be nothing more than an allotropic form of carbon. In 1814 and 1815 he does not seem to have done much beyond examining some ancient colors, and discovering chloric and iodic acids, and working on their salts.

The year 1815 was a fruitful one, although it contains only one discovery, that of the safety lamp, to which his name is indissolubly connected. Returning in August from an excursion in Scotland, through the coal districts, he was painfully interested at the loss of life in coal mines occasioned by the explosions of firedamp. He had specimens of firedamp from different coal mines collected and sent up to him in London, and on the 9th of November he sent in two papers on the subject to the Royal Society, the lamp being perfected in the following month. This invention he gave freely to the world; had he patented it, his gains would have been incalculable.

In 1817 he was presented with a service of plate worth £2,500 by the coal owners and miners of England and Scotland, and shortly after he received the honor of baronetcy. The possibility of unrolling the Herculaneum papyri next engaged his attention, and he published some observations on the phenomena of volcanoes and on Oersted's electromagnetic experiments. In 1820 he succeeded Sir Joseph Banks as President of the Royal Society, a post which he retained for seven years.

He did little more remarkable work from this time forward, his last remarkable papers being those on the preservation of copper sheathing from corrosion by voltaic means, and the Bakerian Lecture for 1826, on the relation of electric and chemical changes, which may be said to be the crowning point of his brilliant career.

In 1825 he fell into ill health, and symptoms of a paralytic nature began to manifest themselves. His illness was greatly aggravated by the unexpected death of his mother in the September of the next year, and at the end of November he had a severe paralytic seizure which greatly affected his right side. He consulted the first physicians of the day, without relief; but nature, for whom he had done so much in unfolding her wonders, came to his assistance, and he soon gained sufficient strength to correct the proof sheets of his collection of discourses before the Royal Society.

In the spring of 1827 he started for Italy, in company with his brother, and wandered about pleasantly until the October of that year, when he returned to England. In March, 1828, he once more started for his favorite Carinthia, traveling through Switzerland and Italy, and bringing up at Rome in February, 1829.

During the whole of his travels he was at work on his "Salmonia" and "Consolations of Travel," besides making numberless observations on torpedoes, the effects of voltaic electricity on muscle and nerve, and a crowd of notes on various interesting points in natural history.

He had barely arrived in Rome, when he had a paralytic seizure which rendered his right side quite powerless. His brain, however, was quite unimpaired, and on the 25th of February he dictated a letter to his faithful brother John, who was naval surgeon at Malta. In those days Malta was nearly three weeks' journey from Rome, and he did not arrive till the 14th of March, when the illustrious patient had so far recovered as to be able to drive out. In April Lady Davy arrived in Rome from London with the second edition of the "Salmonia," the sight of which seemed to revive him wonderfully. On the 30th of April he left Rome for Geneva, where he arrived on May 28th, apparently greatly enlivened and improved by his journey, but at two o'clock on the following morning his brother was roused up and reached his bedside only just in time to receive his last sigh. At his own request he was buried in the cemetery outside the walls of the city in which he died.—*Chemical News.*

LIGHT AND HEAT IN GAS-FLAMES.

AT the recent meeting of the American Gas Light Association, Dr. T. O'Connor Sloane (Brooklyn) read a paper as above.

It is well known to us, he said, that heat, in its industrial applications, is wasted to a great extent. The old problem of the conversion of heat of low into corresponding heat of high temperature, has to be solved, and to its non-solution the waste in most cases is due.

Theoretically, one pound of coal should melt forty pounds of iron, yet this result is never even approached in metallurgical practice.

I wish to examine very cursorily the loss of heat in a gas flame. Light is here produced by the intense heat. The combustible gases are peculiarly fitted to produce such heat, because, as they are already in the gaseous state, they do not, in their combustion, have to make the step from solid to gaseous, as solid combustibles do.

The light given by the flame is due to the ignition of particles of solid matter. Carbon is present in the unignited gas in combination with hydrogen, as constituent atoms of gaseous hydrocarbon. When the gas burns, the heat of the flame decomposes these compounds; solid carbon, in a state of almost molecular division, is liberated, and becoming white hot, or incandescent, emits light. It travels upward through the flame, until reaching the top and outer zones, it is burnt into carbon dioxide, commonly called carbonic acid gas.

All the light of gas is due to the ignition of this carbon. The proof of this fact is, that while gases and liquids ignited may give light, it can always be determined by the spectroscopic analysis whether light is due to an ignited gas or not. Theoretically, and in fact, the spectrum of light derived from the ignition of a gas is discontinuous, while liquids and solids ignited give a continuous one. On subjecting the light of illuminating gas to this examination, it is found that it is due to the ignition of solid or liquid matter, because its spectrum is continuous. As there is no reason for the belief or probability that there is a liquid there present, we find that its light is derived from an ignited solid, and by analysis we find that carbon is the only substance present that remains in the solid state at elevated or even ordinary temperatures.

This proves the fact. A *quasi* proof is found in the deposition of carbon, in the form of lampblack, upon a cold body immersed in the flame. Therefore, as a light-producer, all the work of a flame is the heating of carbon to a white heat.

I shall now proceed to consider the arithmetic of the process, to show what waste of heat takes place, and what a sacrifice of economy to convenience the whole operation is.

I will start with a gas composed of the following principal constituents:

	By Weight.	By Volume.
Hydrogen (H)	5·00	50·00
Marsh gas (CH_4)	63·00	39·40
Carbon monoxide (CO).....	19·00	6·70
Olefiant gas (C_2H_4)	11·00	3·93
Water (H_2O).....	2·00	1·11

This represents about such a gas as is now delivered in New York. For ease of calculation, I will use the analysis by weight, and refer everything to 100 parts of the gas.

The olefiant and marsh gases supply the flame with its solid carbon; and, to make every allowance, we will assume that all the carbon contained in them is dissociated, and plays its part in producing the light of the flame. They contain 55·67 parts of this carbon. The heat developed by burning each of the combustible gases has been determined by physicists. If we multiply the amount of hydrogen and other combustible gases, each by its own heating power, we shall have the total heating power of the flame. Thus, one part (by weight) of hydrogen will raise 34,462 parts of water one degree centigrade; therefore, $34,462 \times 5 = 172,310$ is the number of parts of water which the five parts of hydrogen in the gas under consideration will raise one degree centigrade in temperature.

Performing a parallel computation for all the constituents that will burn, we find that 100 parts of the gas will raise 1,169,317 parts of water one degree centigrade. 1,500 degrees centigrade is not far from the temperature of the incandescent carbon. We will assume that this number of degrees of heat has to be imparted to the carbon by the flame. Dividing 1,169,317 by 1,500, we have 779·5, the number of parts of water which 100 parts of gas will raise 1,500 degrees centigrade. But 100 parts of this gas, in their combustion in air, will have to heat 815 parts of nitrogen derived from the atmosphere. Multiplying this number by 0·2438, the specific heat of nitrogen compared with water, we obtain 198·69, the corresponding weight of water. This, *plus* the water in the gas, must be subtracted from the total work. Doing this, it gives as a result that 100 parts of our gas should be able to raise 578·8 parts of water 1,500 degrees centigrade. If we divide this number by 0·2411, the specific heat of carbon, we shall have the corresponding weight of carbon, or 2,400. Dividing this (the theoretical) by 56·67 (the actual) efficiency of gas, we obtain 42·4 as the figure expressing the relation of theory to practice; in other words, the gas in its combustion generates enough heat to produce 42·4 times the light it does.

The efficiency of gas I have determined on the supposition that all the carbon in the marsh gas plays its full part in the illumination. But this is not true; the light is due almost entirely to the olefiant gas. The supposition that it is the carbon of this constituent mainly that is dissociated and made incandescent, is more than probable.

This carbon in the gas under consideration amounts to 9·43 parts. Substituting this figure for 56·67 in the former calculation, our ratio of practice and theory is expressed by 254·50; or the gas generates enough heat to produce 250 times the light it actually does. This figure seems—and I am not at all ready to say it is not—extravagant; but even if it is so, the other one, the first deduced, is too small. The truth lies somewhere between the two, and indicates at least a field for experiment.

ON RESORCINE COLORS.

By MESSRS. BINDSCHEDLER AND BUSCH.

To manufacture resorcine, 180 pounds of fuming sulphuric acid of 80° Baumé are subjected to distillation with 48 pounds of pure benzine. At first benzosulphuric acid distils over, then benzodisulphuric acid. The acid removed from the recipient is mixed with water, heated to the boiling point, and then neutralized by slaked lime. The solution, containing all the acid in the form of benzodisulphate of lime, is filtered and evaporated to dryness at 212° F. To 120 pounds of the dry mass are added 300 pounds of caustic soda, dissolved in water; the mixture is heated for eight or nine hours in an iron boiler to about 740° F., which causes the mass to solidify. After cooling it is dissolved in 125 gallons of water, and boiled for a short time to allow the escape of the sulphurous acid formed. The liquid deposits a small quantity of tar, which is removed. After cooling and filtering the liquid is brought into an apparatus, consisting of a series of copper cylinders, holding about 65 gallons each. After they have been filled with the liquid, ether, in the form of vapor, is passed through the liquid and extracts the resorcine formed. The solution of resorcine is subjected to distillation in retorts, in which the resorcine remains, after cooling, in the form of a crystalline mass. Fluoresceine may be prepared from it by fusing 100 parts of resorcine, together with 75 parts of pure anhydrous phthalic acid, at a temperature not exceeding 440° F. Yellow eosine, soluble in water, is prepared as follows:

Two pounds of fluoresceine are dissolved in 2½ gallons of alcohol. To the solution are added 2 pounds 3 ounces of bromine, under constant stirring. A precipitate of tetrabromfluoresceine is formed. It is collected on a filter, washed with alcohol, redissolved, neutralized with caustic soda, and allowed to crystallize. It may also be prepared in the following manner:

Ten pounds of fluoresceine are dissolved in 50 gallons of water. Then 22 pounds of bromine are dissolved in a solution of caustic soda; both solutions are mixed, enough muriatic acid is added to produce a slight sour reaction, and the precipitate formed collected on a filter. It is washed out, redissolved in water, and allowed to crystallize. Blue eosine is a corresponding iodine compound, made in a similar manner, and invented by Kussmaul in 1876.—*Chem. Notizblatt.*

SUBSTITUTION OF DIFFERENT METALS IN ULTRAMARINE COLORS.

By treating ordinary blue ultramarine with nitrate of silver, Unger obtained a green ultramarine color, containing about 40 per cent. of silver. In a similar manner yellow silver ultramarine has been produced by Heumann, by increasing somewhat the quantity of silver. Heumann endeavored to substitute sodium for the silver in these colors, and obtained the following results: 1. Sodium may be substituted for the silver except about 15 per cent.; any further substitution alters the color. 2. This substitution cannot be accomplished in less than 24 hours.

By heating silver ultramarine with dry chloride of sodium, a blue ultramarine, free from silver, was obtained, resembling ordinary ultramarine, but lacking the violet tint of the latter. It also contains less sulphur. In converting the blue ultramarine again into the yellow the original shade of yellow is rarely only reproduced. On repeated reconversions the shade changes considerably. Finally no blue ultramarine is produced any more, but only a greenish powder. Potassium ultramarine was obtained by heating silver ultramarine with dry chloride of potassium. The reaction commences at about 600°, and ceases when the temperature has risen to nearly 1,200°. Care must be taken not to exceed that temperature, as otherwise only a dirty-looking gray powder will be obtained. Silver ultramarine, heated with chloride of barium, is converted into barium-ultramarine, which is of a yellowish brown color. Similar compounds, some of which possess beautiful colors, may be produced with zinc (violet), manganese (gray), and other metals. They all have the characteristic properties of ultramarine.—*Bulletin de la Société Chemique de Paris.*

APPARATUS FOR TITRATION.

By W. F. K. STOCK.

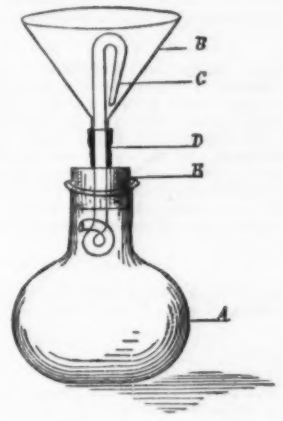
THE apparatus usually employed to procure the absence of atmospheric air during the solution of metallic iron in acids consists of a flask fitted with a cork, through which is passed a tube bent twice at right angles. When in use the free end of this tube is made to dip below the surface of water contained in a second flask or small beaker. The chief defects of this arrangement are:

1st. Want of portability.

2d. Necessity for some form of support for tube.

Having recently had occasion to execute a considerable number of determinations of metallic iron in samples of steel and iron, I constructed an apparatus entirely free from these defects, and very much more simple and convenient to manipulate. The following is a description of the new arrangement, which will be readily understood by the aid of the accompanying cut.

A is a flask of 200 c.c. capacity; B, a glass funnel 7



mm. diameter; C, a glass tube of such a size as just to pass through stem of funnel, B. D, an India-rubber joint connecting B and C, and forming a perfectly tight joint; E, an India-rubber stopper, bored so as to pass stiffly upon C.

Perhaps a word upon the construction and use of the apparatus may be admissible. Having selected a tube of the proper size, the upper bend is turned on so that the point of the tube, C, which should be narrowed to 1·5 mm., falls into the apex of B. B is then placed in position and secured by D; the stopper, E, is next fitted on C, and finally the lower bend of C is turned on, taking care to allow so much tube as will prevent E being injured by heat.

In working the apparatus it is only necessary to place sufficient water in B to cover end of C, in order to secure exclusion of air. The most certain source of heat is a sand-bath. Using this I have never had a case of untimely regurgitation. Immediately the required solution is effected, the apparatus is removed from the source of heat, and recently boiled water is run into the funnel B to the required extent.—*Chem. News.*

PALLADIUM.—J. Violle.—The mean specific heat of palladium at 100° = 0·0593. Its melting temperature is 1500°.

HÆMOCYANIN, A NEW SUBSTANCE FROM THE BLOOD OF OCTOPUS VULGARIS.—L. Fredericq.—The liquid portion of the blood of the cuttles contains a colorless albuminoid substance, forming with oxygen an unstable compound of a deep blue color. This substance plays, in the respiration of the cuttles, the same part as does hæmoglobin in that of the Vertebrata. The venous blood of the cuttles is colorless, but the arterial is a dark blue. If hæmocyanin is ignited it leaves an ash rich in copper, which seems to be in the same condition and to fulfill the same functions as does iron in hæmoglobin.

TEST FOR ALCOHOL IN ETHEREAL OILS AND CHLOROFORM.—A very simple and safe method for detecting alcohol in ethereal oils or chloroform is the following: The suspected oil is shaken with water. After the latter has separated it is drawn off, and now a small quantity of sulphuric acid and a little bichromate of potassium are added. When alcohol is present the water will immediately turn green and the smell of aldehyde will be perceptible. Very small quantities of alcohol may be detected in this manner.—*Zeitschr. d. Oest. Apotheker-Zeitung.*

PHOSPHATE SOAPS.

IT has recently been observed that putrid urine has the property to remove grease and dirt from the articles with which it comes into contact. At first it was thought that this property was due to the carbonate of ammonia present in the urine, but subsequent experiments have shown that this action depends entirely on the phosphates of the alkalies. A soap was therefore manufactured containing a certain percentage of phosphate of soda, which has proved to be very effectual in cleansing, more so than other soaps. It renders hard "water, containing much lime, soft," as the lime is precipitated as a phosphate. The phosphate soap is not injurious whatever, and does not affect the most delicate fabrics, while it is of beneficial influence on the skin. It may also be remarked that waste paper containing such soap may be used as a fertilizing agent for gardens. These soaps are now extensively manufactured in Germany and France.—*Chem. Zeitung.*

REACTION OF TARTARIC AND CITRIC ACIDS.

TARTARIC acid may be easily distinguished from citric acid by its reaction on bichromate of potassa. A cold, saturated solution of this salt being prepared, a little tartaric acid is added, which immediately colors the solution dark brown, while carbonic acid is generated. Citric acid colors the solution only slightly and only when present in larger quantity. Five per cent. of tartaric acid present in a solution will color the bichromate solution intensely brown, and 1 per cent. even will darken the solution considerably. Wine vinegar, prepared from white wine, colors, when boiled with an equal measure of the bichromate solution, the latter dark red, and the intensity of the color depends on the quantity of tartrates present in the vinegar. Vinegar made from beer, wood, or mere dilutions of acetic acid will not show this reaction.—*Chem. Notizblatt.*

A PECULIAR OBSERVATION.

MR. HIRN, the well-known engineer, lately reported the following to the French Academy of Sciences:

An iron bar about three feet long and three inches thick was held at one end by one workman while another one struck the other end with a hammer. The one holding the bar felt, immediately upon every blow, that the bar became quite hot at the end he held, but cooled again just as quick. Mr. Hirn being informed, tried the experiment himself, and experienced the same sensation of heat. He estimated the elevation of temperature at about 60° F. He was quite surprised, as the heat exceeded the possible effects of the blow as calculated. The effect seems to be entirely subjective, the source of the heat being apparently located in the hand. Mr. Hirn believes that the vibrations of sound may, under certain circumstances, produce the same sensation of heat on the skin, similarly as a blow or pressure on the eye will cause the apparition of light. He proposes to observe the conditions of the bar during the hammering by means of a Melloni thermometer.—*Chem. Zeitung.*

SILGWART'S BATH FOR ETCHING GLASS.—Dissolve 22 grains of fluoride of sodium in 2 pints of boiling distilled water in an iron vessel, adding enough water afterward to preserve the measure. To this solution 14 grains of glacial acetic acid are added. Into this bath the well-cleaned glass articles are placed and allowed to remain several hours. A rough crust is formed on the glass, consisting of a compound of the fluoride of sodium and the glass. This crust is removed by washing with warm water. The surface of the glass is very smooth and possesses a fine grain.—*Chem. Notizblatt.*

COMPOSITION OF FRENCH BRONZES.—The following gives the composition of some French bronzes for different purposes:

	Antimony.	Copper.	Tin.	Zinc.
Very tough bronze	—	88	12	2
Bronze for eccentrics, collars, etc.	—	90	10	2
Bronze for supports, medium hard	—	86	14	2
Hard bronze	—	84	16	2
Bell metal	—	78	22	—
Bronze for journals, etc.	8	4	90	—

The medium hard bronze mentioned is especially adapted for printing cylinders and similar parts subjected to high pressure.—*Deutsche Industrie Zeitung.*

INSOLUBILITY OF IODATE OF LEAD.—C. A. Cameron communicated to the Society of Analytical Chemists of Dublin that he has demonstrated by experiment the complete insolubility of iodate of lead. Iodic acid and iodates of the alkalies precipitate lead more completely than sulphuric acid, especially in the presence of a little alcohol. Iodate of lead may thus be used for determining lead quantitatively. It is, however, soluble in solutions of the chlorides, iodides, and bromides of the alkalies; the solution of iodic acid used for testing must always be freshly prepared.—*Chem. Notizblatt.*

MODE OF PREVENTING THE CONTAMINATION OF WATER WITH LEAD.—When a hot solution of impure sulphuret of potassium is allowed to remain for about half an hour in leaden pipes the latter will be completely covered with a vitreous, hard coat of completely insoluble sulphuret of lead, and water can now be conducted through the pipes without being contaminated.—*Chem. Notizblatt.*

SEPARATING PHOSPHORUS FROM IRON AND STEEL.—The Messrs H. Schultze-Berge & J. Barnstorf, of Oberhausen, have obtained a German patent for the following process for separating phosphorus from iron and steel. It is based on the observation of Dr. Schoenn and Prof. Fresenius that phosphorus is separated from its compounds by calcium and magnesium at a red heat. They use, therefore, chloride of calcium or the chlorides of the metals of the alkaline earths, heating them with the iron to the melting point of the latter, excluding the air. The carbon contained in the iron remains unchanged, while the phosphorus is entirely eliminated.—*Chem. Zeitung.*

PRODUCTION OF ALCOHOL WITHOUT FERMENTATION.

IN the course of the controversy between M. Berthelot and M. Pasteur with regard to Claude Bernard's posthumous work on Fermentation, the first named investigator referred to the production of alcohol from sugar without the intervention of any ferment or organisms of any kind. His most recent experiments in this direction have been successful; it is said that by simultaneously hydrogenizing and oxidizing sugar, M. Berthelot has succeded in producing alcohol, though in very small proportions. At one time it was thought that alcohol could only be produced by the influence of living organisms, but chemists have now proved that it may be formed by purely chemical action. We believe this most recent discovery of Berthelot's refers to the production of alcohol by the electrolysis of a solution of sugar.

A HARMLESS GREEN FOR PAPER HANGINGS.

AN excellent substitute for the poisonous arsenical green color used for paper hangings, etc., is said to be found in a compound consisting of three equivalents of barytes and two of manganic acid. The pigment may be prepared by thoroughly mixing three or four parts of moistened caustic barytes, two parts nitrate barytes, and two parts oxide of manganese; fusing the mixture in a crucible heated to dull redness; pulverizing the residual mass, and washing the powder first with boiling and then with cold water, in an atmosphere free from carbonic acid. In this way is obtained a fine emerald green powder, which, under the microscope, is seen to consist of small transparent hexagonal crystals. It is applied to paper by means of thin glue, or the white of an egg.

[Continued from SUPPLEMENT 168, page 2680.]

FILARIA IN THE EYE.*

By CHAS. S. TURNBULL, M.D. PH.D.

FILARIA IN THE EYE OF MAN.

ALTHOUGH it seems a shocking thing to contemplate, it is, nevertheless, true that filaria, and living ones, too, have been found in the human eye.

Dr. Nordmann,[3] of Odessa, describes the circumstances which led him to discover the existence of entozoa in the eyes of several vertebrates; and he gives a minute account of them, illustrated by beautiful figures, representing their form and internal structure. His researches during the years 1830 and 1831, embraced numerous eyes of horned cattle, sheep, pigs, frogs, lizards, and fishes, with some from the human subject, and birds. He found entozoa of the genus *filaria* in the human eye, in that of the haddock (*gadus aglefinus*), of the genus *ascaris* in the frog, of the genus *oxyuris* in the perch, of the genus *cysticercus* in the pig, and *trematoda* in great abundance in fishes generally. In fishes he first found entozoa in the vitreous humor, but he subsequently met with them in the crystalline lens and the capsule, between the laminæ of the cornea, in the iris and retina, and in the aqueous humor (Lib. cit. pp. 1–6). In the crystalline lens of some fishes they are so numerous as to render it more or less opaque, and thus to impair or injure sight (Lib. cit. pp. 19, 20).

A species of filaria (*Filaria medinensis?*) has been seen under the conjunctiva oculi, in the West Indies. Schön has quoted some facts of this kind. A case was related to him by Dr. Gaertner, who resided in the West Indies, and considered it to be the guinea worm.[4]

Dr. Thos. G. Morton, of this city, has given an interesting account of a filaria (*Dracunculus* or *Filaria loa*) removed by a native woman from beneath the conjunctiva of the eyeball of a negress at Gaboon, West Africa, with a brief history of the parasite, and Professor Leidy's description of the specimen.[5]

Cobbold says: "These worms are identical with those described by Guyot as dwelling beneath the conjunctiva of negroes at Congo, and the Gaboon region generally."[6] Davaine has reported several similar cases, and refers to them as *La filairie de l'orbite.*[7]

The *filaria lentis* (Cobbold), and what is identical, the *filaria oculi humani* (Nordmann), was discovered by the last named investigator in the year 1831.[8] Dr. Nordmann examined two lenticular cataracts taken from an elderly man, half an hour after they had been extracted by Prof. von Graefe. In one of these, which was partially surrounded by the capsule, he observed in the Morgagnian fluid two very small and delicate rings, which he clearly recognized under the microscope as convoluted filariæ. One of the two had been injured in the middle, so that the intestines had come out of the body, and were visible as slender threads. The other was uninjured, of uniform thickness, three-quarters of a line long, and extremely narrow. It was spirally convoluted and dead. A simple intestinal canal, a mouth with visible papillæ, a uterus, and a prominent anal aperture could be distinguished (Lib. cit. pp. 7, 8).

In 1832 he was present at two operations of extraction, performed on old women by Prof. Jüngken, and found a living filaria, five lines and a half long, in the act of casting its skin (in der haütung begriffene), in the lens of the first patient (a case of green, lenticular cataract); no living extraneous body was found in the other lens. The second case was more interesting, as it presented the first example of microscopical entozoa, possessing suckers (*Trematoda Rudolphi*), being found in the human eye; eight individuals of the genus *monostroma* were found in the substance of the lens. These minute beings were situated in the upper strata of the crystalline; they were one-tenth of a line long, and moved sluggishly when placed in warm water. The examination took place immediately after the operation. In neither case was the opacity complete, and the lenticular substance was soft (Lib. cit., Zweites Heft, Vorwort, p. 9).

M. Davaine also mentions a comparatively recent case of filaria in the anterior chamber of the eye, but full particulars do not appear to be published. The case previously cited is by Sichel,[9] from whom we gather that the specimen was brought forward by Quadri, of Naples. The living worm was in the vitreous humor of a woman thirty years of age. The function of the eye was perfectly normal. The latter authority exhibited the parasite *in situ* at a meeting of the Ophthalmological Congress held at Brussels.

Von Ammon found a filaria in a lenticular cataract, of which the nucleus was firm and the exterior pulpy. The cataract was extracted. He has figured the animal, of its natural size and magnified.[10]

Then, again, there is the case observed by Gescheidt,[11] in which Von Ammon operated for congenital cataract. In this case there were four filariæ, of the genus *distoma*. The largest measured one-sixth, the smallest one-fifteenth, of an inch.[12]

Cobbold considers them embryonic *nematodes*, which have accidentally or otherwise selected the human body as their intermediary host.

Mauthner[13] says he saw what he supposed to be a dead filaria floating about in the perfectly clear vitreous humor of a man forty years of age.

Von Wecker, the author of the second half of the fourth volume of "Graefe und Saemisch's Augenheilkunde," gives no new cases, but mentions a case of supposed filaria spiralis (?), which he considered a rudimentary persistent hyaloid artery.

The presence of filariæ within the human eye is, beyond a doubt, of rare occurrence; no instances on record are of recent date, and our more modern text books and works on ophthalmology either omit them altogether or else refer but briefly to the few cases herein mentioned.

Having occurred once, filariæ will doubtless be found again, and if there exists a "*filaria sanguinis hominis*," as Drs. T. R. Lewis of India, Bancroft of Australia, and especially Dr. Manson[14] of China, have pointed out, we must look for it wherever the blood circulates.

Seldom is it that the oculist in his busy round stops to scrutinize the cataractous lens he so dexterously extracts, or to examine in minute detail every floating opacity in the vitreous body, and I must confess I am of the opinion that it behooves us to be more on the lookout for the phenomena in question.

(The writer of this paper will be exceedingly indebted for any reliable account of a worm or worms in the human eye.)

[3] Nordmann, "Mikrographische Beiträge zur Naturgeschichte der Wirbellosen Thiere, Erstes Heft," pp. 11–13.

[4] Handbuch der Pathologischen Anatomie des Menschlichen Auges, pp. 236, 227.

[5] *American Journal of the Medical Sciences*, Phila., July, 1877

[6] Entozoa, London, 1864, p. 388.

[7] Davaine, Traité des Entozoaires, Paris, 1860, p. 750.

[8] Nordmann, Mik. Beiträge z. Nat. d. Wirb. Thiere.

[9] Iconographie Ophthalmologique, p. 707; also Zander, Der Augenspiegel, 2 Auflage, p. 190.

[10] Klinische Darstellung, Pt. 1, Vol. XII., Figs. 22 and 23.

[11] Zeitschrift für die Ophthalmologie, III. Bandes, IV. Heft., p. 405, "Die Entozoa des Auges, u. s.w."

[12] Zeitschrift für die Ophthalmologie, Vol. III., pp. 75, 76.

[13] M. Optischen Fehler des Auges, 1872.

THE SPECIES OF TAPEWORM NOW PREVALENT.

AT a meeting, last month, of the Academy of Natural Sciences, of this city, Professor Joseph Leidy exhibited two specimens of tapeworm from the human subject. One had been submitted to him for examination by Dr. Levick and the other by Dr. Walter Atlee. During the past fifteen years he had examined from two to five specimens yearly, sent to him by physicians who desired his opinion regarding the specific characters of the worm. It was formerly supposed that the tapeworm commonly found in man was tænia solium, the immature form of which infests the hog, and obtains a lodgment in the human body by the use of raw or badly cooked pork. He had been surprised to find that all the specimens examined by him during the time mentioned belonged to another species, the tænia medio-canellata, the larva of which is found in the cow. It is, therefore, the lovers of raw or rare beef who foster this form. This species is readily distinguished from tænia solium. The head is conspicuously larger, of a square shape, and blackish color. It is provided with four suckers, but without the hooks so characteristic of tænia solium. There is also a striking difference in the joints, by means of which detached segments may be distinguished from those of the pork worm, the ovaries in tænia medio-canellata being exceedingly complex and branched, and of a dark color, while in tænia solium they are comparatively few and simple, and of a lighter tint. Leuckart states that the Abyssinians are infested with tapeworm, almost to a man, from their habit of eating raw beef, which they esteem a great delicacy. They not only eat the meat uncooked, but the living animal is driven up to the door of their banqueting halls, and pieces of quivering flesh are cut from it and served to the guests, until the poor tortured creature falls, exhausted by pain and loss of blood. These people do not consider the presence of the parasite a disadvantage, but rather otherwise. When the worm grows too large they simply cause the expulsion of some of the segments, and allow the head and the remaining portions to grow again until they become of an inconvenient size.—*Med. and Surg. Reporter.*

NITROUS OXIDE UNDER PRESSURE.

P. BERT finds that, by placing a patient in an apparatus where the pressure can be increased to two atmospheres, nitrous oxide can be administered so as to produce continued anæsthesis, while the blood receives its normal supply of oxygen and the normal conditions of respiration are maintained. From various experiments on animals, he thinks that gas administered in this way will be harmless, however much the insensibility may be prolonged.—*Comptes Rendus.*

A NEW ENEMY TO THE TEA PLANT.

AMONG the pests of the tea plant may be reckoned an apparently new insect, in the form of a caterpillar, which has lately shown itself on an estate on the Nilgiris. The owner of the estate experimented on a few of them, picked off his trees, and the following are a few particulars:

1. The caterpillar is about an inch long, with five pairs of legs in addition to a pair where the body points off at the stern.

2. It has a small cream-colored head, with a pair of minute black eyes, and has the power of drawing in its head, which it does when it comes into contact with any suspicious object.

3. It is of a bright salmon color, growing to a pinky color on the stomach. It is marked with one, and in some cases with three, black stripes down the back. Those having three stripes are, to all appearance, the older insects.

4. Each insect has, on its back, a number of protuberances which correspond to the number of its legs, and which taper to a minute point. This is the most notable point of physical peculiarity, for through each of the protuberances the little creature emits a drop of bright transparent fluid as soon as it is touched on the back with a straw or stick; and when it does so it looks as if it has so many drops of dew resting upon it.

5. It feeds voraciously upon the tea leaf, and in four or five days half a dozen have bared a large bush of every leaf. They do not, however, touch the young buds, for the reason, probably, that there is more of tannin in them. This, however, is merely conjecture.

6. The owner of the estate on which the caterpillar was found kept also a few in a bottle to watch their habits and development. Of the small number of five insects which were placed in a tart bottle with a perforated cork and a small supply of tea leaf, frequently changed, four died and dried up against the side of the bottle, and only one underwent a metamorphosis, and has been kept in a separate phial, without any further change being noticed, for more than three weeks. It located itself before the change along the center of a tea leaf on the upper side, and drawing the leaf into a fold, spread over itself a covering of a brownish color and of the consistency of a dense cobweb. It has remained in that state ever since.

7. The insect when alive crawls by folding its body up

[14] In a paper entitled "Report of Hæmatozoa," Patrick Manson, M.D., of Amoy, China, says: "1. That a large ratio of the population of this province, and probably of other parts of China, is infested with the *Filaria sanguinis hominis*. The exact ratio cannot yet be stated, but if my observations are a fair guide, one in thirteen is near it. 2. That the *Filaria sanguinis hominis* may be present in the blood, and yet the hosts be in good health and exhibit no morbid phenomena. 3. That in the same persons it may be present at one time and absent at another, for that at one time or another it is generally associated with elephantoid disease, and is almost certainly connected with the causes of such affections. 5. That it is sometimes associated with a diseased condition characterized by frequently recurring attacks of fever, accompanied by general anasarca, unconnected with heart or kidney disease."

and using alternately the front and back halves of its body to seize the branch along which it travels.

8. Wherever it crawls it leaves a web behind it, in the same way as many caterpillars do, but the web it pays out is so strong that it requires some pressure to move or break it.

9. The body of the insect is very tough, and when shaken off the tree it was difficult to kill even by rubbing with a stick, so that each insect had to be cut in two with a knife.

10. The drops of liquid which it casts out through the pores on its back are also of a property which causes a cobweb to stick to anything to which the liquid attaches.—*Madras Times.*

A GIGANTIC AMERICAN DEEP-SEA CRUSTACEAN.

THE study of the animal life which exists at great ocean depths has during the last few years yielded results that were not only entirely unlooked for, but which have also completely modified the opinions of naturalists as to the distribution of the marine fauna. The governments of England, Scandinavia, and the United States, fully aware of the great importance of such studies, have from time to time put at the disposal of zoölogists all the necessary appliances, in the way of ships and apparatus, for the better prosecution of such investigations; and it is by these means, attended with considerable expense, that we have succeeded in learning the nature of the ocean bottom.

Our own government especially has undertaken many dredging expeditions in American waters, and not long ago authorized Mr. Alexander Agassiz to explore the bed of the Gulf Stream, between the southern extremity of Florida and the island of Cuba. In December, 1877, this naturalist, having sailed on board the steamer Blake, made a series of dredgings, some of them in 2,000 fathoms of water, and succeeded in bringing up a large number of rare and curious animals.

GIGANTIC CRUSTACEAN, FROM A DEPTH OF 5,730 FEET IN THE GULF OF MEXICO. VENTRAL VIEW: ⅔ NATURAL SIZE.

The crustaceans, with the consent of the director of the Coast Survey, were sent to France to be studied by M. Milne Edwards. This collection proved rich and varied, and one of the most extraordinary of the animals formed the subject of a paper read before the French Academy on the 6th of January of the present year.

This remarkable crustacean (for a representation of which we are indebted to *La Nature*) is a gigantic isopod, dredged up from a depth of 955 fathoms off the northeast coast of Yucatan, in the vicinity of the Tortugas. The animal, which M. Milne Edwards has named the Giant Bathynomus (*Bathynomus giganteus*), is not only remarkable for its enormous size (9 inches long by 4 inches broad), but also for the peculiar arrangement of its respiratory apparatus—very different from that of any other known crustacean. It would seem that the respiratory organs of an ordinary isopod would have failed to meet the requirements of an animal like the Bathynomus, living at such an immense depth in the ocean, and it became necessary, therefore, that it should be provided with special contrivances of a greater functional power. These consist of a numerous series of finely-divided branches placed between the false abdominal legs, and each part of which, studied with the microscope, is seen to consist of a tube covered with very fine hairs. By its general conformation, the grouping of its rings, the structure of its mouth, and the arrangement of its legs, the Bathynomus belongs undoubtedly to the division of ambulatory isopods, but it is distinguished from the spheromians by its free abdominal joints and by the development of its caudal swimming apparatus. In these particulars it approaches the cymothoadians, but it offers in the conformation of its head, antennæ, and eyes certain characters which separate it from all groups known. Contrary to what would have been supposed in regard to an animal living at such a depth and in such a dark medium, its eyes are very highly developed, each one being formed of upward of 4,000 square facets; and instead of being situated on the top of the head (as they are in the wandering cymothoadians), they occupy its inferior face and surround the base of the antennæ.

It is probable, as M. Milne Edwards justly observes, that the study of animals such as this will throw some light on the history of fossil crustaceans, especially of the trilobites.

THE BRADFORD OIL SAND.

By CHAS. A. ASHBURNER, M. S.

THERE is possibly no district in the oil regions of Pennsylvania whose geology has attracted the attention of the oil operator and geologist less than that of the Bradford district.

Although petroleum was first found in the producing sand in November, 1871, it was not until the early part of the year 1875 that a profitable oil horizon in McKean County was acknowledged to exist, even by those most largely interested in the production of oil.

The first well sunk to the Bradford sand was drilled by Mr. James E. Butts, Hon. C. H. Foster, and Job Moses, with a few others, under the name of the Foster Oil Co. This well is situated on the Gilbert farm, 2 miles north-east of Bradford. Slush oil was found at 751 feet and the producing sand at 1,110 feet. The well produced 10 bbls. a day.

From November, 1871, to December, 1874, no wells were drilled that amounted to anything.

On December 6th, 1874, Messrs. Butts & Foster struck the sand, in what is known as Butts well No. 1, on the Archy Buchanan Farm, 2½ miles northeast of Bradford. This well started off with a daily production of 70 bbls., and was really the first well that attracted the attention of the oil men to the possibility of finding a productive district in the county.

The unparalleled growth of the Bradford district is evidenced by the fact that in December last, four years from the completion of the Butts well, the average daily production was 23,700 bbls. of crude oil.

The early drillers in the territory regarded the oil as coming from the same geological horizon as that occupied by the Third Sand along Oil Creek in Venango County.

Inconsistent as this idea was with known facts in the geology of northwestern Pennsylvania, the oil sand was named Third Sand, and the drillings being examined, First and Second Sands were discovered 600 and 300 feet respectively above the lower or producing sand.

The opinion which had frequently been expressed by expert geologists, that there was little probability of finding the Oil Creek oil north of the P. & E. R. R., was denied on the basis of what the driller regarded as overwhelming evidence.

As far as nomenclature went the comparison between Venango and McKean Counties was perfect. Along the Allegheny River in the former county, the drill had proven the existence of three distinct sand horizons producing petroleum, which had long been known as the First, Second, and Third sands, the last being the most productive.

In McKean County a persistent sand was found producing petroleum, with two other sand horizons above it.

One mile above Oil City the top of the Third Sand is 528 feet above ocean level. At Bradford, which is 64 miles north, 55° east, of Oil City, the top of the producing sand is only 414 feet above ocean level. Between these two places the surface rocks have a progressive dip to the southwest.

The interval between the outcropping conglomerates and the geological horizon of the Oil Creek Third Sand, probably varies but little between the two localities, so that the stratum, whatever it be, occupying the horizon of the Third Sand should be found near water level at Bradford.

The top of the sand which produces the oil at Bradford is struck 1,030 feet below water level.

In Venango County the average distance from the top of the First Sand to the bottom of the Third is 315 feet. In McKean County the distance from the top of the First Sand, so called, to the bottom of the producing sand is 660 feet.

Here, then, were two facts which could not be denied, if the producing sands at Oil City and Bradford were the same; first, at Bradford the sand is 1,000 feet (more or less) too low; and second, the group of oil rocks over 300 feet too thick.

The practical driller was at sea and obliged to succumb to the more intelligent views of the geologist.

Mr. John F. Carll, assistant in the oil regions, in the early part of 1876, published the fact that the Bradford producing sand was probably 1,000 feet below the Oil Creek Third Sand. Facts since obtained show this to have been a close estimate.

To make a comparison of the rocks passed through by the drill in the two districts, it was necessary to have complete and well authenticated well records.

No accurate register of the rocks has ever been kept by any of the producers in the Bradford district.

This fact can readily be accounted for, when it is remembered that, with the exception of the wells at State Line and Limestone, N. Y., the bulk of the production comes from one horizon.

In December, 1877, Professor Lesley, State Geologist, appointed Mr. Arthur Hale to the special work of obtaining a correct record of the Dennis & Co.'s well No. 1, which was about to be drilled on the high summit to the southwest of Bradford. This well was completed in the early part of 1878.

The measurements were made with great care, and wherever the rock was found to change, a specimen or specimens were secured for future study.

The depth of the well is 1,719 feet. The elevation above ocean level is 2,055 feet, Bradford Station, on the Erie Railway, being 1,444 feet. This record is, without doubt, the *longest detailed and accurately measured record* of any oil well in the United States. A complete description of the record is contained in a paper which I read before the American Philosophical Society last September.

The top of the well is stratigraphically 115 feet below the bottom of the Olean Conglomerate, which is the lowest member of the Coal Measure Conglomerate No. XII., and which caps the highest summits in the vicinity of Bradford.

The Mauch Chunk No. XI., if present in the rock series, in this part of the county is represented by the shales immediately underlying the Olean Conglomerate.

Drilling was commenced in the shales belonging to the Pocono formation No. X.

The following is a condensed description of the record as published.

	Thickness.		*Depth.*	
POCONO FORMATION NO X.				
Surface clay	4 feet to		4 feet.	
Olive gray shale	11	"	15	"
Gray sandstone	33	"	48	"
Gray shale	19	"	67	"
Blue and gray S. S., shale and slate	49	"	116	"
Gray S. S.	16	"	132	"
RED CATSKILL FORMATION NO. IX.				
Red shale	6	"	138	"
White and gray S. S.	59	"	197	"
Red shale Paintrock	18	"	215	"
Gray S. S., few pebbles	23	"	238	"
Bluish slate	77	"	315	"
Gray S. S.	5	"	320	"
Red slate	8	"	328	"
Gray S. S. and slate	39	"	367	"
Red shale mottled	15	"	382	"
CHEMUNG FORMATION NO. VIII.				
Gray slate	8	"	390	"
Dark and gray S. S.	45	"	435	"
Fine S. S and slate	216	"	651	"
Gray S. S. and slate	61	"	712	"
Red S. S.	10	"	722	"
Dark slate	20	"	742	"
S. S. and chocolate shale	63	"	805	"
Gray slate and S. S.	201	"	1006	"
Red slate and shale	14	"	1020	"
Gray S. S. and slate	36	"	1056	"
Gray and yellow S. S., First Sand so called	25	"	1081	"
Gray S. S. and slate	44	"	1125	"
OIL SHOW IN LOWER PART.				
Gray slate	175	"	1300	"
Brown S. S.	17	"	1317	"
Slate	28	"	1345	"
Brown and Gray S. S., Second Sand so called	36	"	1381	"
Gray slate with occasional sand beds	283	"	1664	"
BROWN SAND, THIRD OR PRODUCING OIL SAND	54	"	1718	"
Slate and S. S.	1	"	1719	"

The Bradford sand is geologically the lowest oil producing sand in Pennsylvania, with the exception of the Smethport sand, which has but recently been discovered near Smethport, McKean County, and which is only producing about 2 bbls. a day.—*Stowell's Petroleum Reporter.*

GLACIERS IN THE UNITED STATES.

ACCORDING to Dr. F. V. Hayden, it was not known until last season that any genuine glaciers existed within the limits of the United States, east of the Pacific coast, but last summer while two of the divisions of the Geological Survey under his charge were exploring the Wind River mountains in Wyoming Territory, they found living glaciers on the east side of the range. On the east base of the Wind River peak, there is a mass of snow and ice 900 yards long and 500 wide, exhibiting all the phenomena of the true glacier. On the east base of Fremont's peak (which is over 14,000 feet in height) there were discovered two glaciers, one of which covers an area of one and a quarter square miles, and the other three-quarters of a square mile. These were marked by enormous crevasses; also by lateral and terminal moraines. They appear to be only insignificant remnants of the vast glaciers that must have covered these mountains during the true glacial period. On the west side of the range the moraines and glaciated rocks are found on a vast scale. On the west side of the range, a glacier must have formerly existed, eighty miles long and twelve wide, with the arms extending up the gorges of the streams, to the very water divide. These glaciers are to be more fully described in the forthcoming Twelfth Annual Report of the U. S. Geological Survey.

THE TUOLUMNE CAVE.

THIS cave has been explored for half a mile; and Gardner, the discoverer, thinks he has determined the extent of it to be over four miles. On the first of December, 1878, Gardner says he was engaged in working his placer claim, which is distant 300 feet from the entrance of the cave, when a squirrel perched itself upon a tree near by, and commenced to chatter and spit acorn chucks at him. He repaired to his cabin, armed himself with a double-barreled shot-gun, and fired seven rounds at his squirrelship—the seventh just as his little tormentor was disappearing in the dark recesses of this crevice in the ledge above his claim. Descending by ladder ten feet, you reach the floor of an inclined archway, dipping at an angle of thirty-five degrees, from twenty to thirty feet in height, by thirty feet in width. Descending the incline, which is one hundred feet in length, you reach the floor of the grand archway, from forty to sixty feet in height, varying in width from twenty to thirty feet, from which radiate scores of similar archways leading to spacious chambers. Lofty ceilings draped with brilliant stalactites glitter and sparkle in the light of a lamplike gem The floors and wall of this subterraneous hall are entirely coated with stalagmites. The location is between the South and Main Stanislaus rivers, near their junction, and one mile northeast of the ancient and classical town of Pine Log.

ARCHÆOLOGICAL EXPLORATIONS IN TENNESSEE.*

By F. W. PUTNAM, Curator of the Peabody Museum.

DURING the month of September, 1877, friends in Nashville tendered to me such facilities for archæological research in central Tennessee as enabled me to make extensive explorations in several localities, the results of which are briefly recorded in the following pages.

My first examination of the ancient stone graves, which are so numerous in the State of Tennessee as to form a marked feature of its archæology, was in the prehistoric cemetery on Zollicoffer Hill. It was soon found, however, that the graves at this place had been so much disturbed as to make any work done here rather unsatisfactory as to results. The building of Fort Zollicoffer on this hill was probably the first cause of disturbance of the cemetery, while its easy access from Nashville has recently led many curiosity hunters to the spot.

One of the graves at this place had been opened by a friend a few days before my visit, and in it he had found the remains of what he believed to be a mother and child. The few bones he collected and kindly gave me, however, showed conclusively that while those belonging to the adult had been long buried, and were probably those of the body for which the grave had been made, those of the infant were on the contrary of a much later date, and were evidently of a child that, not many years ago, had been placed in this old grave, which was near the surface and formed a handy place for burial. This fact is mentioned simply to show the caution with which such examinations must be made in order to secure trustworthy results.

One grave which I opened at Zollicoffer Hill, though only a few inches under the surface, had escaped former disturbance. This grave was formed of six slabs of stone on one side and five on the other, with one slab at the head and one at the foot; forming a grave five feet eight inches in length inside measure, and six feet outside, the average width being eighteen and the depth sixteen inches. The side stones were unevenly broken to dimensions of eight to fifteen inches in width, by about twenty inches in depth, and two or three inches in thickness. The two stones forming the head and foot of the grave were larger than those on the sides. All these stones extended a few inches below the floor of the grave, which was made by placing thinner and smaller pieces of stone in such a manner as to form a level bottom to the cist. Five slabs of stone, larger than those used on the sides, rested on the nearly even edges of the upright stones, and, slightly overlapping, formed the cover or top of the grave.

Further examinations in other localities showed that all the stone graves were made after this plan, the only variation being in the size of the stone slabs and in the dimensions of the graves. Any rock was used that could be easily detached in slabs of convenient size. That most common to the localities I visited was limestone and sandstone.

In the grave I described the body had been laid on the back and extended at full length, occupying nearly the whole length of the grave, showing that the person when living was about five feet five inches in height.

From many measurements of the graves taken during my explorations, I am convinced that the people buried in these stone graves in Tennessee were of ordinary stature. Occasionally a grave seven feet, and even of eight feet, in length was found, but in such cases there was always a space of several inches between the bones of the feet and the footstone, and between the skull and the headstone.

In the grave specially mentioned above, the only articles found were fragments of two vessels of clay, which had been placed in the center of the grave, and a pointed implement made of deer's horn.

In another grave of the same character and about the same size, located by the side of the first, and also with the covering stones in place, the remains of the skeleton of an adult were found, and with it, about the center, on one side of the skeleton, were the fragments of an earthen dish. On the breast of this skeleton was the ornament of copper here figured of its actual size (Fig. 1). The cross-like form of this ornament may give rise to the question of its derivation; and had any article of European make, such as glass beads, brass buttons, etc., so common in Indian graves subsequent to contact with the whites, been found in any one of the hundreds of graves I opened in Tennessee, I should consider the form of this ornament the result of contact with the early missionaries; but, from the total absence of articles denoting such contact, I think it must be placed in the same category with the "tablet of the cross" at Palenque, and be regarded as an ornament made in its present form simply because it was an easy design to execute and one of natural conception.

The ornament is evidently made from a piece of native copper hammered and cut into shape. The small perforation at the upper border still contains a fragment of the string by which the article was suspended, preserved by the action of the copper: and on one surface of the copper are slight evidences of its having been in contact with a finely woven fabric, thus showing that this ancient people, who were well advanced in the ceramic art, also possessed the knowledge of weaving.

* From the Eleventh Annual Report of the Peabody Museum of American Archæology and Ethnology, Cambridge, Mass., where the specimens figured and referred to are on exhibition.

On the large estate of John M. Overton, Esq., eight or nine miles south from Nashville, there was formerly an extensive cemetery, and many graves are still to be found about the hill on which stands Mr. Overton's hospitable residence, known as the "Traveler's Rest." At this place Prof. Joseph Jones obtained many of the articles which he has described and figured in his valuable work.

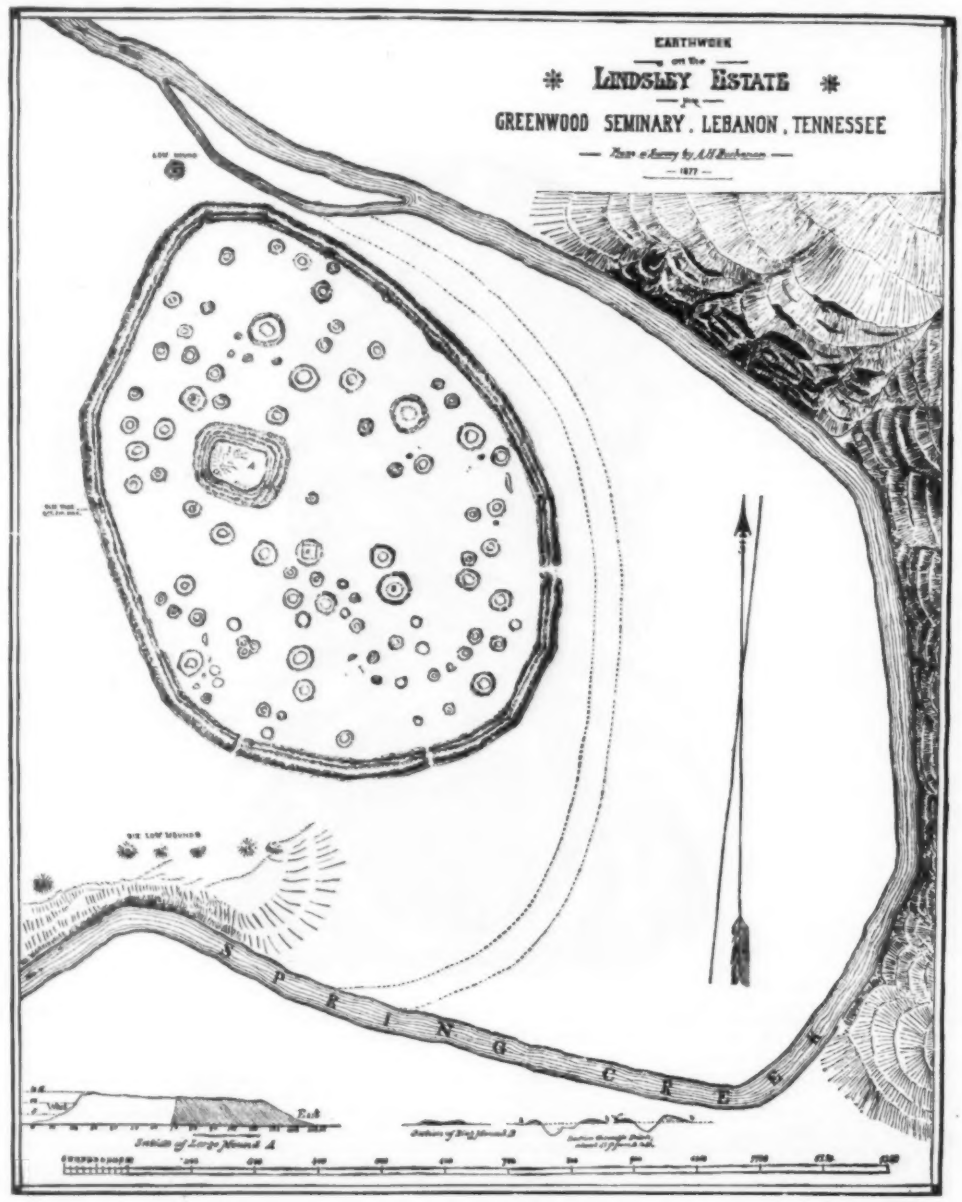
It was my good fortune to receive the kind attentions of Mr. Overton during a short visit to this interesting locality, and thanks to Mrs. Overton, and her gardener, Mr. Edward Cross, I was made the recipient of several very valuable specimens which had been taken from graves on the place, and also had an opportunity to open two graves myself, from each of which I secured pottery, and from one a cranium.

One of the articles of pottery is here represented, of one-half of its diameter (Fig. 2). This is a well-made, rather thick dish, without ornamentation, and was found by the side of the skull.

A short time before my visit, a stone grave was removed by Mr. Cross, and in it were found two interesting articles which he gave to me. One of these is a highly polished discoidal stone, two and a half inches in diameter and one and one quarter thick, made of white quartz; the other is the shell ornament here represented, of actual size (Fig 3).

This ornament is made from a large marine shell, probably a *Busycon*, and is symmetrically carved on the slightly concave surface, as shown in the figure.

The four heads of birds, resting on the rectangular central figure, are represented by simple incised lines. Two



holes near the edge of the disk indicate that the ornament was suspended.*

Mr. Cross also gave me a spear, or arrow point, of jasper with serrated edges, which is represented of actual size (Fig. 4). This flint point was found while cultivating the land in the vicinity of the graves, and with two polished celts, presented by Mrs. Overton, were probably once inclosed in graves which had been destroyed in former years.

In connection with the shell ornament found in the stone grave on Mr. Overton's place, I give the following illustration (Fig 5) of a similar ornament which was given me by the venerable Col. J. D. Morgan, of Nashville, in whose possession it had been for some time. Col. Morgan was not certain that this ornament was taken from a stone grave, though the probability is that it was so found in the immediate vicinity of Nashville. This disk is made from the shell of *Busycon*, and is larger than the one given me by Mr. Cross. Fig. 5 represents this ornament, of one-half its diameter, and will give a better idea than words of the design carved upon it. Like the other, it has two holes for suspension.

Prof. Jones has described and figured a shell disk, found in a stone grave on the banks of the Cumberland, opposite Nashville, the carving on which is identical in its design with that on the one here figured, the only difference being in the number of circles in the two groups. In Prof. Jones' specimen the outer ring contains fourteen circles, and the inner nine, while in our specimen there are thirteen and six respectively. The central spiral figure is the same in both.

Many of these carved disks of shell have been found in the graves and mounds of Tennessee and Missouri, and, with the identity of the associated pottery from the two localities, go far to prove the unity of the people, notwithstanding some slight differences in burial customs.

On the farm now owned by Miss Gertrude Bowling, about four and a half miles southwest of Nashville, were five burial mounds, which, thanks to the kind permission of Miss Bowling, were thoroughly explored. Of these, I personally conducted the work on one of the largest, which was about fifty feet in diameter and between five and six in height. A second and part of a third were examined by Mr. Curtiss under my direction. Major Powell and his party explored the other mounds.

These five mounds, containing the graves of from six to eight hundred persons, were probably the burial places of a former settlement in the immediate vicinity, all other traces of which had long since been destroyed by the cultivation of the land. Not far from this locality, as I was informed, are the remains of a cemetery where the graves were located on the side of a hill; a well-known mineral spring is situated within half a mile of the mounds, and a small winding creek is near by. The locality must have been a desirable one for a permanent village, and, like all other such sites met with in the State, was well chosen for the natural advantages offered.

In the mound which I explored, over two hundred bodies had been placed, with one exception, in stone graves of various sizes. The single exception of a body buried without the care which was used in all the other burials in the mound is of interest, especially as there was no indication that any article had been placed with the body, and while engaged in carefully getting out the skull of this skeleton, I could but feel that it was that of some poor outcast, who had not been considered worthy of a stone grave. The skull of this individual is noted in the table of measurements on p. 294 (Eleventh Annual Report, Peabody Museum), under No. 11,918, and belongs to the ordinary type of skulls from the graves.

The mound itself was formed by several irregular layers or tiers of stone graves, the lowest of which had probably been placed irregularly round the grave first made. These lower graves were formed by making an excavation sufficiently deep to support the side-stones of the grave, but not so as to cover the overlying top-stones, at all events not more than an inch or two. On the graves, offerings of food, etc., probably had been left, which would account for the many fragments of pottery, the several stone implements and other articles found upon the covering stones and by the sides of the graves.

Below several of the graves, near the center of the mound, and, as nearly as could be determined, on the original surface

* Since this was sent to press there has been received at the Museum, from Mr. E. Curtiss, half of a shell disk found on the surface in Humphreys Co., Tenn. This shell disk has carved upon it figures identical with those on the one described above from Overton's farm. The two localities are between 70 and 80 miles apart, and at both places the number of stone graves indicate large settlements. Can these carved shells be regarded as totems? Several distinct patterns are now known, of each of which two or more examples have been found.

of the ground, was a bed of ashes several inches deep, in which fragments of pottery and a few bones of animals were found. In at least two of the mounds near this corresponding beds of ashes were noticed. Over this bed of ashes were several graves, the stones of which they were formed extending but a few inches into the ashes, thus showing that these stone graves were often formed above ground. After these early graves were covered by a few inches of soil, a second tier was placed above them, and eventually this was followed by a third and fourth.

At the highest point on the mound a few graves were found, which, though nearly destroyed by the growth and falling of trees, probably belong to the latest, or fifth tier of graves.

FIG. 1.—ORNAMENT OF COPPER, FROM GRAVE ON ZOLLICOFFER HILL. NATURAL SIZE.

Over the mound was a recent growth of trees, the largest of which was a black walnut, standing on the very center, with its roots reaching down the sides of the mound and penetrating some of the upper graves. The tree was eight feet four inches in circumference at its base, and seven and one half feet at a height of four feet; but, as a section of the trunk only showed between sixty-five and seventy rings of growth, the tree is not of value in estimating the age of the mound, for it is historically known that this region was without Indian inhabitants one hundred and fifty years ago, and, uncertain as we are as to the period when they were constructed, it is certainly safe to state that the mounds were not made after that date.

The mound, formed in the method stated, by the gradual accumulation of the stone graves, was conical in shape, as each irregular tier of graves had a smaller number than that below it. The lower graves were thus, of course, the oldest, though there was little difference in regard to the condition of the bones, and the contents of graves side by side in any of the layers were in entirely different degrees of decay.

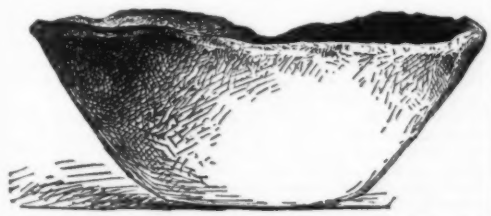


FIG. 2.—DISH FROM GRAVE ON J. M. OVERTON'S PLACE.

It was noticed that no method was followed in placing the head of the body in any particular direction, though in the lowest tier the majority were placed with the head toward the center of the mound, but even among these oldest graves one was occasionally found at right angles to that adjoining. In the upper layers, the graves were placed in all directions, sometimes one would be found lying lengthwise directly over a grave below it, and others were resting crosswise upon two, three, or even four graves in the tier below. It was particularly noticed that, without regard to the proximity of other graves, each was constructed perfectly independent of those adjoining, notwithstanding the fact that the side or head stones of adjoining graves were often in contact. Generally, however, there was a space of about six inches between the graves, and often the space was one or two feet.

The following transcript of my field notes for two days of the six that I spent with my diggers in examining this mound, will give sufficient details to show the character and contents of the graves in this and the adjoining mounds. In designating the several tiers, the lowest is counted as the first, and so on to the fifth, or most recent. The graves here recorded were principally on the eastern side of the mound.

Grave 1. 1st tier. Inside measure, 6 feet 9 inches in length, 1 foot wide, 9 inches deep. An adult, body extended, lying on back, head to west. Bones of the skeleton very dry. Skull taken out perfect, but fell to pieces in cleaning, pieces saved with all the teeth. Took out long bones, part of pelvis, vertebræ, etc. Fragments of a pot, a broken arrow point, and three flint chips in grave. Top of grave covered by four large slabs which projected over the sides.

Grave 2. 1st tier. A child of four or five years, body extended, head to west. Skeleton all gone except portions of left parietal and occipital, several teeth and piece of femur. No article in the grave. Length 3 feet 9 inches, width 11 inches, depth 9 inches. Side rocks extending several inches below the bottom of inside of grave. Two rocks on top.

Grave 3. 1st tier. Grave of an old person, body extended, head to west, 6 feet 9 inches long, 1 foot 8 inches wide. Skull, pelvis, and long bones taken out in good condition. Nothing but skeleton in the grave.

Grave 4. 1st tier. Adult, body extended, head to west, 6 feet 6 inches long, 2 feet 2 inches wide. Took out skull in pieces, long bones, fragments of pottery, and shell of Unio.

FIG. 3.—ORNAMENT OF SHELL FROM GRAVE ON J. M. OVERTON'S PLACE. NATURAL SIZE.

Grave 5. 1st tier. This grave, though 6 feet 6 inches long and 2 feet 1 inch wide, was that of a youth or a woman of delicate frame. With the exception of portions of the long bones, the skeleton had nearly decayed. No article in the grave.

Grave 6. 1st tier. 3 feet long, 2 feet 5 inches wide. A young child, all the bones decayed except the shafts of the long bones of arms and legs. No articles in the grave.

The grave of an adult, designated as No. 1, was between the two graves of children, Nos. 2 and 6.

Graves 7 and 8, 3d tier. These graves were close together, of same size, the indications being that they were made at the same time. Each grave was 2 feet by 1 foot 4 inches, and each covered by a single slab. No. 7 contained bones of an infant in such position to show that the body had been extended when placed in the grave. Several of the bones in a good state of preservation, and were saved. In this grave found fragments of pottery and a muscle shell.

In No. 8, the bones of the head and body were in a compact mass of 12 by 6 inches, and had the appearance of having been buried in a bundle. In this grave were also fragments of pottery.

Grave 9. 1st tier. 7 feet long. Adult. Long bones, pelvis, and under jaw saved. A ring of pottery, 1½ inches in diameter, resting on under jaw.

Grave 10. 1st tier. That of a child, 3 feet long, 1 foot wide. Part of skull and the long bones saved. No articles in grave.

Grave 11. 1st tier. Adult. 7 feet long. Skull and long bones saved. No sign of pottery or articles of any kind.

FIG. 4.—FLINT-POINT FROM MR. OVERTON'S PLACE. NATURAL SIZE.

Grave 12. 2d tier. Long grave. Skeleton too far decayed to save any portion. No articles in grave.

Grave 13. 2d tier. 3 feet 8 inches long, 14 inches wide, 9 deep. A child about five years old. Long bones and under jaw saved. No articles in grave.

Grave 14. 3d tier. 3 feet long, 9 inches wide, 7 deep. That of a child. Portions of the skull and long bones saved. No articles in grave.

Grave 15. 2d tier. 7 feet long, 11 inches wide, 6 inches deep. Adult, body extended on back, head to north. Skull, long bones, and pelvis saved. The following articles were found in space between the skull and headstone:

Large spear point and knife of flint; several flint chips; two awls made of deer's horn, and two others made of bone; a shell bead; tooth of a beaver, tooth of a carnivorous animal; wing bone of a bird.

Grave 16. 2d tier. Next west of 15 and of about the same size, head to north. Long bones and jaw saved. Fragments of pottery.

Grave 17. 2d tier. Old person, head to west. Skull, long bones, pelvis, and other bones saved. Two flint chips in grave. No signs of pottery.

Grave 18. 3d tier. Small grave containing portions of much decayed skeleton of a youth. Shell of Unio and a flint chip in grave.

Grave 19. 4th tier. On the western side of the mound and the upper tier at this place. The covering stones of this grave had been disturbed. Head to west, feet toward center of mound. Nothing saved.

Grave 20. 1st tier. In part under Nos. 15 and 16. Youth of about eighteen years. Jaw and arm bones saved. A slender flint drill, fragments of pottery, and a few flint chips in grave.

Grave 21. 1st tier. About in center of mound and running north and south. 6 feet long. Body extended, head to north. Skull saved. No articles in grave.

Grave 22. 1st tier. 6 feet 3 inches long. In same line with 21, and the headstones of the two graves in contact. Head to south. The skull and some of the long bones saved. Flint chips in grave.

Grave 23. 1st tier. Grave of a child, 3 feet 2 inches long, 12 inches wide, 5 inches deep. Head to west. Bones much decayed. None saved. No articles in the grave.

FIG. 5.—ORNAMENT OF SHELL FROM NASHVILLE.

Grave 24. 1st tier. On same line with grave 23. Foot stone of 24 in contact with headstone of 23. Two tiers of graves over 23 and 24, the graves resting on 23 and 24 lying east and west, while those in the upper tier were lying north and south. The position of this grave and the condition of its contents mark it as one of the oldest in the mound, though on the eastern side of the center. The grave was very dry and the bones had nearly all been reduced to dust. What remained consisted of a few teeth, a fragment of the femur, small fragments of the tibiæ, and portions of the spongy part of few of the bones. A pipe made of pottery and a few flint chips were found near the teeth, and had evidently been placed near the head.

From these notes it will be seen that from comparatively few of these old graves can either crania or other bones be obtained, and those that are removed require long and patient work. It will also be noticed that a very few graves contained pottery or other articles, though this would not indicate any neglect on the part of friends, as it is probable that many perishable articles were placed with the dead in the graves, while the numerous fragments of pottery, the stone implements, etc., found among the graves, as already noticed, suggest that offerings were placed over the graves as well as within them.

(To be continued.)

THE NATURE OF THE ELEMENTS.

AT a crowded meeting such as is seldom witnessed of the Royal Society in December, Mr. J. Norman Lockyer, F.R.S., read a lengthy paper, in which he discussed the evidence derived from spectroscopic observation of the sun and stars and from laboratory experiments, which has led him to the conclusion that the so-called elements of the chemist are in reality compound bodies. In order that the line of argument followed by Mr. Lockyer may be understood, it will be necessary briefly to refer to the results of previous researches.

As a rule, in observing spectra, the substance to be examined is volatilized in a gas flame or by means of sparks from an induction coil, and the light is allowed to fall on the slit of the spectroscope; the spectrum is then generally one in which the lines run across the entire field, but by interposing a lens between the spark apparatus and the slit of the spectroscope, Mr. Lockyer was enabled to study the various regions of the heated vapor, and thus to establish the fact, already noted by some previous observers, but to which little attention had been paid, that all the lines in the spectrum of the substance volatilized did not extend to equal distances from the poles. He then showed by the aid of this method that, in the case of alloys containing different proportions of two metals, if the one constituent were present in very small quantity its spectrum was reduced to its simplest form, the line or lines longest in the spectrum of the pure substances alone appearing, but that on increasing the amount of this constituent, its other lines gradually appeared in the order of their lengths in the spectrum of the pure substance.

Similar observations were made with compound bodies. It was also noticed that the lines furnished by a particular substance varied, not only in length and number, but also in brightness and thickness according to the relative amount present.

Armed with these facts, and with the object of ultimately ascertaining more definitely than has hitherto been possible which of the elements are present in the sun, Mr. Lockyer about four years ago commenced the preparation of a map of a particular region of the spectra of the metallic elements for comparison with the map of the same region of the solar spectrum. For this purpose about 2,000 photographs of spectra of all the various metallic elements have been taken, and, in addition, more than 100,000 eye observations have been made. As it is almost impossible to obtain pure substances, the photographs have been carefully compared in

order to eliminate the lines due to impurities, the absence of a particular element, as impurity, being regarded as proved if its longest and strongest line was absent from the photograph of the element under examination.

The result of all this labor, Mr. Lockyer states, is to show that the hypothesis that identical lines in different spectra are due to impurities is not sufficient, for he finds short line coincidences between the spectra of many metals in which the freedom from mutual impurity has been demonstrated by the absence of the longest lines. He then adds that five years ago he pointed out that there are many facts and many trains of thought suggested by solar and stellar physics which point to another hypothesis, namely, that the elements themselves, or at all events, some of them, are compound bodies. Thus it would appear that the hotter a star the more simple is its spectrum, for the brightest, and, therefore, probably the hottest stars, such as Sirius, furnish spectra showing only very thick hydrogen lines and a few very thin metallic lines, characteristic of elements of low atomic weight, while the cooler stars, such as our sun, are shown by their spectra to contain a much larger number of metallic elements than stars such as Sirius, but no non-metallic elements, and the coolest stars furnish fluted band spectra characteristic of compounds of metallic with non-metallic elements and of non-metallic elements. These facts appear to meet with a simple explanation if it be supposed that, as the temperature increases, the compounds are first broken up into their constituent "elements," and that these "elements" then undergo dissociation or decomposition into "elements" of lower atomic weight.

Mr. Lockyer next considers what will be the difference in the spectroscopic phenomena, supposing that A considers B as an impurity and as a constituent. In both cases A will have a spectrum of his own. B, however, if present as an impurity, will merely add its lines according to the amount present, as we have above explained, whereas, if a constituent of A, it will add its lines according to the extent to which A is decomposed and B is set at liberty. So that as the temperature increases the spectrum of A will fade if A be a compound body, whereas it will not fade if A be a true element. Moreover, if A be a compound body, the longest lines at one temperature will not be the longest at another. The paper chiefly deals with a discussion from this point of view of the spectra of calcium, iron, hydrogen, and lithium, as observed at various temperatures, and it is shown that precisely the kind of change which is to be expected on the hypothesis of the non-elementary character of the elements has been found to take place. Thus each of the salts of calcium, so long as the temperature is below a certain point, has a definite spectrum of its own, but, as the temperature is raised, the spectrum of the salt gradually dies out, and very fine lines, due to the metal, appear in the blue and violet portions of the spectrum. At the temperature of the electric arc the line in the blue is of great intensity, the violet H and K lines, as they are called, being still thin; in the sun the H and K lines are very thick, and the line in the blue is of less intensity than either, and much thinner than in the arc.

Lastly, Dr. Huggins' magnificent star photographs show that both the H and K lines are present in the spectrum of *a* Aquilæ, the latter being, however, only about half the breadth of the former, but that in the spectrum of *a* Lyræ and Sirius only the H line of calcium is present. Similar evidence that these different lines may represent different substances appears to be afforded by Professor Young's spectroscopic observations of solar storms, he having seen the H line injected into the chromosphere seventy-five times, the K line fifty times, but the blue line, which is the all-important line of calcium at the arc temperature, was only injected thrice.

In the spectrum of iron two sets of three lines occur in the region between H and G which are highly characteristic of this metal. On comparing photographs of the solar spectrum and of the spark taken between poles of iron, the relative intensity of these triplets is seen to be absolutely reversed, the lines barely visible in the spark photograph being among the most prominent in that of the solar spectrum, while the triplet, which is prominent in the spark photograph, is represented by lines not half so thick in the solar spectrum. Professor Young has observed during solar storms two very faint lines in the iron spectrum near G injected thirty times into the chromosphere, while one of the lines of the triplet was only injected twice. These facts, Mr. Lockyer contends, at once met with a simple explanation if it be admitted that the lines are produced by the vibration of several distinct molecules.

The lithium spectrum exhibits a series of changes with a rise of temperature precisely analogous to those observed in the case of calcium.

In discussing the hydrogen spectrum, Mr. Lockyer adduces a number of most important and interesting facts and speculations. It is pointed out that the most refrangible line of hydrogen in the solar spectrum, h, is only seen in laboratory experiments when a very high temperature is employed, and that it was absent from the solar protuberances during the eclipse of 1875, although the other lines of hydrogen were photographed. This line, also, is coincident with the strongest line of indium, as already recorded by Thalen, and may be photographed by volatilizing indium in the electric arc, whereas palladium charged with hydrogen furnishes a photograph in which none of the hydrogen lines are visible. By employing a very feeble spark at a very low pressure the F line of hydrogen in the green is obtained without the blue and red lines which are seen when a stronger spark is used, so that alterations undoubtedly take place in the spectrum of hydrogen similar to those observed in the case of calcium.

In concluding this portion of his paper, Mr. Lockyer states that he has obtained evidence leading to the conclusion that the substance giving the non-reversed line in the chromosphere, which has been termed *helium*, and not previously identified with any known form of matter, and also the substance giving the 1,474 or coronal line, are really other forms of hydrogen, the one more simple than that which gives the h line alone, the other more complex than that which gives the F line alone.

There can be no question that the facts brought forward by Mr. Lockyer are of the highest importance and value, and that they will have much influence on the further development of spectrum analysis, to which he has already so largely contributed. But his arguments are of a character so totally different from those ordinarily dealt with by chemists, that they will hesitate for the present to regard them as proof of the decomposition of the elements, until either they are assured by competent physicists that they cannot be explained by any other equally simple and probable hypothesis, or until what Mr. Lockyer has foreshadowed as taking place to such an extent in other worlds has been realized beyond question or cavil in our own laboratories. It has been suggested that the same molecule may be capable of vibrating in different ways at different temperatures, and thus of yielding different spectra, just as a bell may give out different notes when struck in different ways, and although Mr. Lockyer has replied to this objection, it can scarcely be regarded as finally disposed of.

The fact, however, as Mr. Lockyer has pointed out, that the change from the spectrum of a compound to the lowest temperature spectrum of its metallic element is of a similar character to and even less in degree than the change from the lowest temperature spectrum of the metal to the spectra which it furnishes at higher temperatures does not appear to favor such a hypothesis, and from the similarity in the phenomena it is difficult to deny that in both cases decomposition does not equally take place. Professor Young's observations on the injection of particular lines into the chromosphere during solar storms are also difficult to reconcile with this view, and if the conclusions drawn from previous researches are correct, it also does not account for the short line coincidences which led Mr. Lockyer to his hypothesis.

Chemists are careful to teach that what are at present regarded as elements are not necessarily simple bodies, but merely substances which they are unable to decompose or which they have no special reason to regard as compound bodies. The remarkable relations, both in atomic weight and properties, existing between many of the elements, tend, indeed, to show that they are related in the manner Mr. Lockyer supposes. We sincerely hope that he will continue his researches in this direction, and we trust that at no very distant time he may be able to bring forward evidence sufficiently clear to convince even the most skeptical.—*London Times.*

MEMORABLY COLD WINTERS.

THE severity of the present winter having been regarded as in a high degree remarkable by many, it has occurred to the writer that a brief compilation from various sources, embracing an account of unusually cold winters at various times and places, might prove of decided interest to the general reader. For this purpose alone the following paragraphs have been thrown together (premising that all degrees of cold here mentioned are for temperatures below zero, unless otherwise noted).

Dr. Kane, while wintering in Smith's Sound (78 deg. 37 min. North latitude), in the winter of 1853, probably experienced the most intense cold ever felt by man. He says of it: "On the 17th of January our thermometers stood at 49 deg., and on the 20th the range of those at the observatory was 64 to 67 deg.

"On the 5th of February our thermometers began to show unexampled temperature. They ranged from 60 to 75 deg., and one very reliable instrument stood upon the taffrail of our brig at 65 deg. The reduced mean of our best spirit-standards gave 67 deg., or 99 deg. below the freezing point of water.

"At these temperatures chloric ether became solid, and carefully prepared chloroform exhibited a granular pellicle on its surface. The exhalations from the surface of the body invested the exposed or partially clad part with a wreath of vapor. The air had a perceptible pungency upon inspiration, and when breathed for any length of time it imparted a sense of dullness to the air-passages."

The lowest temperature recorded by any of Dr. Kane's thermometers was 80 deg., afterwards corrected with ten other bulb instruments and reduced to a mean of 68 or 100 deg. below freezing point of water. On the 7th of January, 1855, the reduced mean of the lowest temperature was 69·3 deg.

Dr. Hartwig says: "About the same time (Feb. 9 and 10, 1854) Sir E. Belcher experienced a cold of 55 deg. in Wellington Channel (75 deg. 41 min. N.), and the still lower temperature of 62 deg. on January 13, 1853, in Northumberland Sound (76 deg. 52 min. N). Whymper, on December 6, 1866, experienced 58 deg. at Anatto, Alaska (64 deg. 42 min. N)."

Capt. Howgate, in his interesting article in the *North American Review*, on "The Cruise of the Florence," says that the coldest day experienced by her navigators was in Annanatook Harbor, January 21, 1878, when the mercury fell to 52 deg.

In Portland, Maine, the mercury reached its minimum point in the winter of 1856 at 18 deg.; in Boston, at 13 deg.; in Albany, at 25 deg.; in Pittsburg, at 12 deg.; in St. Paul, at 35 deg.; in Ft. Laramie, at 14 deg.; in Ft. Kearney, at 12 deg.; in Leavenworth, at 20 deg.; in Cincinnati, at 11 deg., and in St. Louis, at 5 deg.

The Kansas City *Journal* quotes from its old files:

"On the night of the 24th of December, 1855, the Missouri River at this place was frozen over. It is now near five weeks that the river has been a highway for teams of horses, mules, and oxen. We put this fact on record for coming years. We have now had near seven weeks of hard freezing weather—a fact unparalleled in the history of this country. People will hereafter refer to the long cold winter of 1855–56. The Indians say it is the severest known for a quarter of a century, nothing like it being seen by the present generation." And under date of Saturday, February 2, 1856: "The cold weather of the past few weeks has been general. From every part of America—from Halifax to Cuba we have accounts—and it is everywhere spoken of as the coldest ever known. At Memphis the citizens are putting up their own ice, a circumstance unknown before. The floating ice has reached the mouth of the Mississippi—a fact unheard of even to tradition. The Brazos River in Texas is frozen sufficiently hard for the crossing of teams. In Cuba they have a real Northern winter. At St. Paul, Minnesota, the thermometer has been 41 degrees below zero."

And again, on February 9, one week later still: "The weather continues unabated. On Sunday and Monday (3d and 4th) the thermometer stood 28 and 30 degrees below zero. We have been looking for Dr. Kane for the last four weeks."

And, finally, March 1: "The river at this place broke up on Monday morning last, the 25th of February, 1856—having been closed sixty-two days. The shore is piled with broken ice at the present writing, but the channel is almost entirely clear. We have no advices from above and cannot say how far it is open. To-day (Friday) it is snowing heavily, the ground being completely covered."

The coldest days within twelve years in this city have been February 6, 1872, when the thermometer marked 12 deg. at 7 A.M.; December 24, 1872, 16 deg. at 7 A.M.; January 20, 1873, 21 deg. at 7 A.M.; January 16, 1877, 12 deg.; December 16, 1878, 16 deg. at 7 A.M.

The present winter has been a phenomenal one in the United States, by reason of universal snow storms and cold weather. The severity of the latter is attested by the records of the Signal Service Corps. On January 2, at 3·42 P M., the thermometers at the various signal stations marked as follows:

Chicago, Ill., 9 deg.; Davenport, Iowa, 14 deg.; Indianapolis, Ind., 4 deg.; La Crosse, Wis., 10 deg.; Leavenworth, Kas., 3 deg.; Omaha, Neb., 5 deg.; St. Louis, Mo., 1 deg.; St. Paul, Minn., 8 deg.; Yankton, D. T., 16 deg.: while the snow varied in depth at the same stations, from six inches to two feet.

For the extremes of cold reached in former times we have no authority at hand more ancient than Horace, who thus records the weather in Rome along about the year 25 B.C.

> "Vides ut alta stet nive candidum
> Soracte, nec jam sustineant onus
> Silvæ laborantes geluque
> Flumina constiterint acuto."

Flammarion, in his work on the Atmosphere, devotes a chapter to a description of the extremely cold winters within one hundred years prior to 1872. In 1776 the Tiber, the Rhine, the Seine, and even the Rhone, rapid as it is, were nearly entirely frozen over. The winter of 1788–9, the precursor of the French Revolution, was one of the longest and most severe winters that ever prevailed in Europe. In Paris the cold commenced on November 25 and lasted fifty consecutive days, commencing to thaw January 13, when the snow was found to be twenty-six inches thick. In the great canal at Versailles the ice was two feet thick. Water froze in very deep wells, and wine became congealed in cellars. The mercury at Paris, on the 31st of December, was 7·2 deg.

The cold was equally severe elsewhere. At Lyons and at Toulouse the Rhone and the Garonne were frozen over, and even the sea itself for several leagues off the Atlantic coast. The Rhine was crossed with loaded wagons, and the Elbe with heavy carts. People rode on horseback over the harbor at Ostend, and during the Christmas holidays the Thames, in the neighborhood of London, was covered with shops. In Toulouse the very bread was laid before the fire to be warmed and then broken with a hatchet; in Galicia, near the end of December, thirty-seven persons were found dead in three days, and the very fish perished in the ponds in France. In Bâle, in Switzerland, the thermometer marked 35 deg.; at Warsaw, in Poland, 26 deg.; at Dresden, 25 deg.; at St. Petersburg, 23 deg.; at Strasbourg, 45 deg.; at Tours, 13 deg.; and at Marseilles the lowest point reached was on the 31st of December, when the mercury stood at 1·4 deg. Fahrenheit. The winter of 1794–95 was also very severe, the mercury sinking at Paris, on the 25th of January, to 10·11 deg., being the coldest day ever known there. Pichegru, then in Holland, sent a detachment of cavalry across the Texel with orders to capture the vessels of the enemy caught at anchor in the ice. During that of 1798–99 the Meuse, the Elbe, the Rhine, and the Seine were frozen over, and a regiment of dragoons, starting from Mayence, crossed the Rhine upon the ice instead of at the bridge at Cassel, which had been removed. The lowest temperature marked was 0·3 deg. above zero, December 10, 1798.

The winter of 1812–13 will ever be remembered in history. It witnessed the retreat of the French army from Russia amid all the horrors that succeeded the capture and the conflagration of Moscow. The retreat began on the 18th of November, and was complete on the 23d. On the march to Smolensk the snow fell almost without ceasing. On the 17th the temperature fell to 15·02 deg. according to Baron Larry, and some of the Russian artillery crossed the Dwina upon the ice. From the 26th to the 29th, during the crossing of the Berezina, the river was choked with blocks of ice loosened by the thaw, which began on the 24th. The severity of the weather was soon as great as ever, and on the 30th of December the mercury fell to 13 deg.; on December 3, to 22 deg., and on the 6th of December the mercury stood at 35 deg.

In January, 1820, at St. Petersburg, a temperature of 25·6 deg. was recorded, 11·9 deg. at Berlin, and in France several travelers, farmers, and gamekeepers were frozen to death. The winter of 1829–30 was also a very cold one. In St. Petersburg the mercury sank to 26 deg.; at Nancy, to 15·3 deg.; at Strasbourg, to 10·1 deg., and at Metz to 4·9 deg. In Paris the lowest point was 1 deg. In Switzerland the cold was very severe in the great altitudes. In Yverdun in the plains the thermometer fell in a few hours, from 14 deg. above, to 4 deg. below, and polar snow, the crystallization of which is very close, and which is peculiar to very low temperatures, was observed. The Seine was frozen over from the 28th of December to the 26th of January, and afterward from February 5 to the 10th, making thirty-four days in all. On the 25th of January, after a thaw, the ice from Corbeil and Melun blocked up the bridge at Choisy, forming a wall sixteen and a half feet high. On the 15th of December, 1840, the ashes of Napoleon, brought home from St. Helena, entered Paris under the Arc de Triomphe, and Flammarion says:

"The thermometer exposed to nocturnal radiation had that day marked 6·8 deg. Fahrenheit. An immense crowd, the National Guard of Paris and its suburbs, and numerous regiments, lined the Champs Elysées from the early morning till two in the afternoon. . . . . Soldiers and workmen, hoping to obtain warmth by drinking brandy, were overpowered by the cold and dropped down dead of congestion. Several persons perished, victims of their curiosity; having climbed up into the trees to see the procession, their extremities, benumbed by the cold, failed to support them, and they were killed by the fall."

January 2 the thermometer at the observatory at Mont St. Bernard marked 9·9 deg. The winters of 1853–4 and 1854–5 were also very rigorous, especially in Southern Russia, Denmark, England, and France. The Rhone, the Saone, and the Rhine were all frozen over, and in January, 1858, the Danube and even the Russian ports in the Black Sea. The winter of 1854–5 was more severe. The mercury reached 19·8 deg. at St. Petersburg, and 14·4 deg. at Riga. The Seine was frozen over at Paris, and people crossed it.

The winter of 1870 and 1871 is also memorable in the history of warfare, and from the fatal influence of the cold upon the health of the combatants. Many of the outposts around Paris, and several of the wounded, were found frozen to death on the field. The winter average there was nearly 3 deg. lower than usual, and M. Renou observed 9·4 deg. at Perigueux, and 13 deg. at Moulins. Flammarion sums up the results of a number of tables of low temperature with the following statement:

"The greatest cold yet experienced has been 24 deg. in France; 5 deg. in England; 2 deg. in Holland and Belgium; 67 deg. in Denmark, Sweden, and Norway; 46 deg. in Russia; 32 deg. in Germany; 0 deg. in Italy; 10 deg. in Spain and Portugal. . . In non-European countries it is certain that at Fort Reliance, in British North America, there have been 70 deg. of cold, and at Semipalatinsk, 76 deg."

M. Renou has noticed that the severest winters seem to recur about every 40 years: 1709, 1749, 1780, 1830, 1870.—*Kansas City Review.*

LIFE AT TIMBER LINE.

By Professor C. E. ROBINS, Summit, Colorado.

I HAVE been asked to communicate to the Kansas City Academy of Science a narrative of my experience in the Rocky Mountains, so far as the latter may seem to me to possess general interest for an audience of the character assembled here.

It has not been practicable, in consequence of my absence from accumulated data, to prepare a careful scientific paper for this occasion; and I, therefore, merely design stating from memory in a conversational way, some matters that present themselves in the general mass of recollections growing out of a residence embracing portions of five years—and covering nearly four years of continuous time—at the summit of the Sierra Madre, in Southwestern Colorado. In what I have to say, I shall confine myself to the Summit Mining District and to facts and occurrences personally observed.

The location to which reference is made is most widely known as the Little Annie mining camp, and is situated near the base of South Mountain in Rio Grande county. More definitely, the point is in N. lat. 37° 28' 18", near W. long. 106° 30', and according to Lieut. Wheeler, 11,300 feet above tide. It is almost accurately in line with Syracuse, the most southern city in Europe, and is at the same distance from the equator as Melbourne, the most southern city in the world. Although the Annie camp is everywhere known as "the Summit," it is, in fact, situated in the trough of a synclinal marked on the south by South Mountain 12,500 feet, and on the north by Summit Peak (the Mt. Belleview of Hayden's Drainage Map of Colorado) 12,748 feet high. At the triangulation monument on the latter, may perhaps be had as vast and impressive a mountain outlook as can be found in the United States. Besides a number of peaks over 13,000 feet in altitude, showing on their upper slopes, during the whole summer, snow fields which have probably presented nearly the same general mass and outline in July and August every year since the Jewish exodus, there rises in clear view, 65 miles northwest, the giant form of Uncompahgre, 14,205 feet elevation; and 64 miles east, Blanco Peak, the loftiest pile over which that unhandsome fowl, the bald-headed eagle, can fly and be at home, 14,464 feet above the sea. For a hundred miles in every direction, over Colorado and New Mexico, and perhaps into Utah and Arizona, the eye surveys the mightiest monitors of telluric disturbance in America north of the Mexican line.

On the 29th of July last, the solar eclipse of that date was observed from the monument on Summit Peak under instructions from the Signal Service office at Washington. I wish I could convey to you in adequate words the weird vision that swept down from the northwest through the pulseless stillness of the upper air over the frozen rock billows of the upper lands. But I believe that neither Starr, nor Clarence King, nor John Ruskin—the three men in whom the changeful glories of the mountains have most truly voiced themselves, could do that. I certainly shall not try.

The day of the eclipse was the only occasion when I have known the air at rest as high up as 12,000 feet. It was a favorable circumstance, as were all others connected with the observation.

Since August 1st, 1876, careful meteorological records have been kept at the Little Annie office. They have been as comprehensive as instrumental means allowed. Although the loftiest station except Pike's Peak reporting to General Myer, being a "volunteer," it has unfortunately been without automatic registering appliances of any kind, without barometer, anemometer or psychrometer, without meteorological tables, and several other desiderata. The absence of these has confined observations mainly to temperature, precipitation, sky readings, estimated air movements, and casual phenomena.

Before giving a brief abstract of climate at 11,300 feet in the latitude of Richmond, Va., let us consider the most important factor in that of the Summit, viz.: elevation. The equivalent of altitude for latitude is approximately expressed by saying that every 1,000 feet of elevation corresponds to a removal of 3° of latitude from the equator. This rule would add (climatically) 34° of N. latitude to the geographical position of the Summit. 37° 28' 18"+34°=about 71° 30' N. Now, if you will consult an atlas, you will find that this takes you a considerable distance toward the pole; about 5° inside the Arctic Circle. The line passes to the north of every settlement made by man in Europe and Asia; and north of all except Upernavik, in America. When, however, we get as far as this toward where the meridians meet, we are not quite certain of our rule. I do not know if weather records are kept at Upernavik, and think a nearly six months' absence of solar rays likely to lower the annual average of temperature beyond the reading of the scale given. Still, we have at the Little Annie, the loftiest gold mine worked on the globe, an Arctic climate, as distinctly marked by its fauna and flora, as by the monthly and annual averages of the spirit thermometer.

The following is a brief of temperature and precipitation at the Summit Signal Station during the twelve months ending June 30, 1878:

MONTHS.	TEMPERATURE.			TOTAL RAIN AND MELTED SNOW.	TOTAL SNOW-FALL.
	MEAN.	MAX.	MIN.		
July.....1877	52·8°	69°	43°	3·6 inches.	0· inches.
August..... "	51·5	63	43	2·44 "	1· "
September.... "	43·0	61	26	3·7 "	11·5 "
October..... "	27·5	52	2	4·4 "	44·0 "
November.... "	18·7	42	—24	0·9 "	9·2 "
December.... "	10·3	40	—22	1·0 "	10·0 "
January.....1878	6·3	32	—21	0·7 "	7·0 "
February..... "	6·0	32	—18	2·96 "	29·6 "
March..... "	17·1	48	—12	5·6 "	55·75 "
April ..... "	22·9	48	— 2	5·125 "	51·25 "
May..... "	31·5	54	14	1·3 "	13·0 "
June..... "	40·8	66	26	2·985 "	14·52 "
Sums.	323·4	605	55	34·710	246·82
Means.	26·95	50·4	4·58		

Compendiously stated, the highest temperature reached during the year was 67°+ Fahr., the lowest 24°—, the mean of maximum temperatures was 50.4°+, the mean of minimum temperatures was 4.6°+, and the average annual temperature 5° below freezing point.

Snow has occurred during every month save July since observations began, 29 months ago. *Last* July furnished us with two considerable snow storms, and the column of snow-fall in the *next* annual summary will be unbroken. Hail is frequent during the summer, and few nights pass without frost. Winter begins about the 5th of September and ends about the 10th of June. We have no spring or autumn. Twice the amount of snow falls in March, April and May that reaches us in December, January and February. The annual crop of "the beautiful" is about 24 feet.

I will say here, that the thin, almost vapor-void atmosphere at 12,000 feet altitude is scarcely ever *chilly*. When the temperature rules as low as 10° below zero, the air is generally still. In over 400 miles of travel on snow shoes I have never worn an overcoat or an overshoe, and have rarely felt as cold as I have, heavily dressed, during the present week in Kansas City. The upper snow is like corn meal, light and dry; it rarely gives in melting over 1-10th of its bulk of water. At all seasons, the ground below the surface is frozen to an unknown depth; no excavations in mines or elsewhere having passed the line of perpetual congelation.

The 4th of July, 1877, was celebrated at the Summit by a snow shoe and snow-balling party, in which seven individuals present in this hall participated. Four of them, who had been accustomed for a number of years to fan themselves and fight mosquitoes in the woods on Staten Island on that date, will recognize one marked exception to their previous thermal experiences in endeavoring to commemorate the adoption of Mr. Jefferson's essay. An account of the unique doings on that occasion of these stray Staten-Islanders, was published by the Chief Signal Officer of the Army in his Weather Review for the month named.

From the middle of November to the middle of June, extensive outside locomotion is limited to snow-shoeing. The latter is performed on runners of the Norwegian pattern, and their facile use involves considerable dexterity. When one first mounts two strips of timber 10 to 12 feet long, and tries to stand up on them going down a gravity-impelling grade—one is apt to encounter unexpected experiences. Somehow, one or the other leg is sure to get irretrievably in advance of its mate, and there is a capsize, a *bouleversement* of the entire animal economy. This does no harm to the novitiate who is wrestling with snow shoes, and is productive of inexpressible and prolonged cachinnation to the lookers-on. Snow-shoeing is grand sport; better than skating and devoid of its dangers. It works no bodily ill to be shot into three or thirty feet of snow. There is little danger of bone-fracture, and none of drowning. The best "snow shoe man" that ever came under my observation, was a woman; graceful as a bird in flight—and good for twenty miles an hour on a hard track and sharp grade. The Canadian or web-foot snow shoe is not, save occasionally by new comers, in use in the mountains.

Snow-slides, in immense masses, occur during the spring months. Where they strike the heaviest timber, or the firmest structures, the latter are literally shaved from the ground as by some cyclopean mower. For many years the track of one near the Summit will be visible, where, in a heavier forest than there is in Missouri, a road a hundred feet wide and half a mile long has been cut as straight and clean as any street in Kansas City.

Of casual phenomena, the number of "cloudless days" (I use the term strictly—days when from sunrise to 9 o'clock, P.M., there is not a filament of cirrus on the concave) is perhaps the most remarkable. Fourteen of them were noted during the twelve months ended 31st July, 1877. On the 11th, 12th and 13th of August, 1876, the sun, moon, and several stars were visible from 10 o'clock A.M. to 2 o'clock P.M. On the evening of the 4th of the same month, perhaps the most splendid lunar rainbow ever witnessed was exhibited to the dwellers on the Summit. It appeared about 9 P.M., the moon being full, and lasted fifteen minutes. The chromatic scale was complete in the primary, and the secondary arc was perfectly defined around the entire semicircle. The upper outlines of the mountains were but faintly discovered through the blackness of the storm, while the valley of the North Alamosa was flooded under the arch with an inundation of intense but indescribable light; brighter than that under the most brilliant aurora, but golden. As no words can convey such a picture, we were fortunate in having present at the time an artist who has perpetuated the scene in colors that will not fade.

Of parhelia, we have about half a dozen striking exhibitions annually. Meteors are frequent. Paraselenes, aurora borealis, and mirage, have not been observed.

Repeating that on the Sierra Madre in Southern Colorado we have two seasons—summer, when it rains almost daily—and winter, in which a large majority of the days are clear—I dismiss matters of situation and climate.

It is known to you that the Rocky Mountains represent the latest extensive line of out-thrust and disruption on the earth's surface.

The main axis of the Saguache range is felspathic porphyry, intercalated with occasional granite and trap. The only fossil yet seen in the Summit Mining District is a tree trunk silicified and partially carbonized, lying at over 12,000 feet elevation, of tertiary or later origin. A narrow seam of impure coal is found near by.

First of existing fauna comes *Ursus ferox* (Var. cinnamom.), the largest native mammal on our side of the world. Next is *Felis concolor*, or mountain lion, the most formidable of American cats. Then follow the black bear, elk, mountain sheep, mountain wolf, red, black and cross fox, porcupine, ground hog, fisher, marten, rabbit, squirrel, weasel, cony, chipmunk, mountain rat, mouse and mole. Of birds, we have hawks, owls, ducks, grouse, quails, doves, ravens, blackbirds, snow birds, camp robbers and woodpeckers. Of insects, the cosmopolitan horsefly and mosquito, the bumble bee, honey bee, locust, spider, gadfly, white and yellow butterfly, hornet, and several species of myriapoda. There are no snakes on the ground and no fish in the waters. Leeches have been the only living thing found in the latter. Careful search for snails has not produced a helix.

The magnificent forests of spruce and fir that meet across the gulches and rise at 12,100 feet to timber line, must have foremost mention in any view, however brief, of the Alpine vegetation of the Summit. I counted upwards of 400 annual rings in one of the "forest monarchs" felled for a battery sill in the Annie mill, and gazed with the brief wonder of an ephemeral existence on a life ended before its time—that yet had braved the tempests of four hundred Summit winters—that sat serenely under Summit skies when Columbus was a boy, and had replanted its race before Luther was born. Forests covering thousands of square miles that will cut 40 to 60 cords to the acre, are not the least of the gifts of the Great Hills. We all owe a grateful debt to Secretary Schurz for his initiative in regard to the spoliation and waste of timber on the public lands. If the latter is suffered to go on unchecked for a few generations, it will turn the western plains, which the labor of man is converting from a desert into a garden, back to a desert again. The forests do well enough without man—but man cannot live without the forest.

Every plant at the Summit over six feet high is a conifer—an evergreen. All, spruce and fir. Even the pine is not found within 2,000 feet vertical distance from the Annie camp; it climbs only to the line where *Populus tremuloides* marks the upward limit of deciduous trees. The undergrowth is almost entirely a dwarf variety of salix.

Of flowers, I can speak only generally and briefly. They come up and bloom through the wasting snow about the 30th of May, and disappear about the end of August. For nine or ten weeks the mountains are a garden; the ground glorious with intense and contrasted color. Helianthus and rosa flanda, gentians, daisies, columbines, cowslips, larkspurs, bluebells, and I know not what else, combine to form a flora which, if less gorgeous, cannot truly perhaps be called less beautiful, than that of the tropics. During three summers, industrious and careful collection was made; and I have in Ohio the material for five comprehensive herbariums, which material Dr. Geo. T. Engelmann of St. Louis has kindly consented to classify and name.

Epiphytes, Filices, and Gramineæ, are well represented at 12,000 feet, the latter largely; and our mountain men agree with the Savoyards in affirming that the highest pastures grow the sweetest and most nutritious grasses.

Of wild berries we have the currant, huckleberry, gooseberry, strawberry, and juniper.

On the 14th of June last, as early as the sunniest spot at 11,300 feet was clear of snow, we broke ground for an experimental garden. On 1st October, we made up the account with the following result: Radishes (roots) grew to be 5 in. long and ⅛ in. thick. Turnips to be ¾ in. in diameter. Maize (stalks) to be 3 in. high. Mexican beans, ditto. Peas 5 in. high, and blossomed; no fruit. Potato stems grew to be 6 in. high; longest diameter of tubers ¾ in. Beets (roots) 4 in. long and ½ in. thick. Kohlrabi and parsley did not come up. Nasturtiums grew to be 1½ in. high. Spinach and lettuce grew 3 in. high, and kept green for weeks after all the rest were dead.

Here, at the end of my time, though not at the end of material, I close this brief résumé of Upland life. It seems on looking back an almost weird intercalation in the years. The altitude, the seclusion, the great mountains, the snow-shoe locomotion, the thin air, the entire absence of other than grateful warmth—all the surroundings of an Arctic residence—are like a dream, here at 700 feet over tide. To no one physical feature of our globe does man owe more than to its mountain ranges. Mineral treasures are the least of their contributions to his service. They are sources of life to all below. The increasingly larger knowledge of their relations to climate, to timber-line, to the growth of cultivated plants, to the well-being of useful animals, to storm origin and distribution, to rain-fall and river supply, is constantly investing them with new titles of beneficence.

In all ages they have been nurseries of political and intellectual freedom for mankind. The civilization of Europe and America was born at the feet of the Himalaya with the Aryan race, two miles above the level of the sea. Wherever there is a land favored by nature with a mountain-chain, its inhabitants will make a history, and reflect in personal and national character somewhat of "the strength of the hills."—*Kansas City Review.*

THE WALLED LAKE IN IOWA.

THE greatest wonder in the State of Iowa, and perhaps any other State, is what is called the "Walled Lake," in Wright County, twelve miles north of the Dubuque and Pacific Railway, and 150 miles west of Dubuque City. The lake is from two to three feet higher than the earth's surface. In some places the wall is ten feet high, and fifteen feet wide at the bottom, and five feet wide on top. Another fact is the size of the stones in construction, the whole of them varying in weight from three tons down to one hundred pounds. There is an abundance of stone in Wright County, but, surrounding the lake to the extent of five or ten miles there are none. No one can form an idea as to the means employed to bring them to the spot or who constructed it. Around the entire lake is a belt of woodland half a mile in length, composed of oak. With this exception the country is a rolling prairie. The trees must have been planted there at the time of the building of the wall. In the spring of the year 1866 there was a great storm, and the ice on the lake broke the wall in several places, and the farmers in the vicinity were obliged to repair the damages to prevent inundation. The lake occupies a ground surface of 2,800 acres; depth of water as great as twenty-five feet. The water is clear and cold; soil sandy and loamy. It is singular that no one has been able to ascertain where the water comes from nor where it goes, yet it is always clear and fresh.—*Dubuque Herald.*

A NEW COMPOUND PRISM FOR DIRECT VISION SPECTROSCOPES, HAVING A VERY GREAT DISPERSIVE POWER.—A. THOLLON.—The sulphide of carbon prism presented to the French Academy possesses an extraordinary dispersive power. Instead of being inclosed laterally by plates with parallel surfaces, it is inclosed by prisms of crown glass whose refrangent angles are in an opposite direction to that of the sulphide. The refrangent media are distributed as in the prism of Amici, with this difference, that the angles of the crowns are smaller, and that at entrance as well as at

exit the luminous ray passes always between the summit of the angle and the normal at the surface. This system is intermediate between the simple prism and the direct vision prism, the deviation being less than in the former and the dispersion greater than in the latter. The absorption is almost annulled.

IS THE MOON INHABITED?

[FROM THE FRENCH OF CAMILLE FLAMMARION.]

FOR some years past—for some months even—the study of the moon has made such progress as to entirely modify the ideas that have been accepted during the last twenty years as to the nature of this neighboring world. Important movements are visible on her surface, volcanoes are in activity, and traces of an atmosphere are making themselves manifest. The time has come to examine the problem of her habitableness with all the care and in all the detail that a subject so eminently interesting demands. We shall ask the permission of our readers, then, to examine this curious question with them, by necessarily passing in review all the observed facts that serve to elucidate the problem.

Star of reverie and mystery, pale sun of night, solitary globe wandering beneath the silent firmament, the moon has, in all ages and among all peoples, especially attracted the gaze and thought of man. She is, in fact, our nearest celestial neighbor; and, formed of old at the expense of our globe, out of its very substance, she is connected with us by indissoluble bonds of parentage. Her distance is only 240,000 miles, so that a telescope magnifying 2,000 times brings her within 120 miles of our eyes. A telegraphic dispatch would reach her in a second and a half; a projectile fired from a gun would have to travel only 9 days to hit her; and an express train would take us to her in 8 months and 26 days. Her distance is only the four-hundredth part of that which separates us from the sun, and only a hundred-millionth part of the distance of the stars that are nearest us! It would take only thirty terrestrial globes to bridge the space between the two worlds. Many a man has walked on the earth as many miles as those that separate us from the moon!

The lunar orb has undergone in human opinion as many vicissitudes as if she had been some political personage; now an admirable abode, a paradise at once terrestial and celestial, a region blessed of Heaven, enriched with a luxuriant life, inhabited by superior beings; and now, again, a dreadful abiding-place, disinherited by Nature of all her gifts, solitary and silent, a very tomb, wandering forgotten in space.

THE VARIOUS OPINIONS THAT HAVE BEEN HELD IN REGARD TO THE MOON.

Before the invention of the telescope, ancient philosophers were naturally led to see in her an earth analogous to the one we inhabit. When Galileo directed the first astronomical telescope toward the moon, and recognized in her surface mountains and valleys similar to those that diversify the face of our own planet, and vast gray plains that might readily be taken for seas, the resemblance between that world and ours appeared evident, and it was at once peopled, not with real human beings, but with diversified animals. Then were drawn the first maps of the moon, and it was agreed to baptize these great gray spots that are seen by the naked eye with the name of seas; and these names they still bear at the present day. The astronomers, thinkers, and the intelligent public itself, hoped to see a rapid progress made in the enlargement of telescopes, and it was even proposed, under Louis XIV., to construct a refractor capable of "showing the animals in the moon." But opticians did in vain, the progress of their science was not in accord with the wishes of imagination. On the contrary, the more the instrument was perfected, the more the analogies that had at first been remarked between the moon and earth were obliterated. When the surfaces of the seas were distinctly seen, it was ascertained that not only were they not liquid, but not smooth, and were sandy and rough—being covered with thousands of hills, mountains, valleys, craters, circular pits, etc. Attentive observation succeeded in discovering on the lunar planet neither a single true sea, nor a single lake, nor any certain proof of the presence of water under any form whatever; nor clouds, nor snow, nor ice. Observation, no less attentive, bestowed on the stars and planets at the moment when the moon passes before them and occults them, showed, at the same time, that these stars are neither obscured nor refracted when they touch the limit of the lunar disk, and that consequently the moon is surrounded by no sensible atmosphere. The analogy that had been believed to exist between the two worlds vanished, lunar life disappeared in smoke, and it became customary by degrees to write in all astronomical works a phrase which has already become traditional: *The moon is a dead star.*

This was concluding a little quickly. It was, especially, mistaking singularly the value of telescopic evidence.

Bobinet maintained that if there were on the moon herds of animals analogous to the herds of American buffaloes, or troops of soldiers marching in order of battle, or rivers, canals, railroads, or structures like Notre Dame, the Louvre, and the Observatory, the great telescope of Lord Rosse would permit of their being recognized.

THE BEST WE CAN DO WITH OUR PRESENT TELESCOPES.

It was said, in fact, that this colossal telescope (the mirror of which is 6 feet in diameter, the focal length of which is 56 feet, and which still remains the largest instrument that has been constructed up to the present day) would be able to bear an amplification of 6,000 times. Now, since magnifying a distant object or bringing it near is geometrically the same thing, if we could then bring the moon 6,000 times nearer, we would see her at a distance of 40 miles. But Lord Rosse's telescope is not perfect, and far from being able to stand amplification of 6,000, it cannot, if clear vision is desired, be made to exceed 2,000. The best reflecting telescope, after that of Lord Rosse, is Lassel's, 36 feet in length and with a speculum 4 feet in diameter. The best refractor is the great equatorial at the Washington Observatory, by the aid of which Prof. Hall discovered the satellites of Mars. Its length is 33 feet, and its object glass has an aperture of 26 inches. Now the highest eye-pieces that can be applied to these *chefs-d'œuvre* of optical art do not exceed 2,000, and, under the most favorable conditions of the atmosphere, these high magnifying powers give no definition. What good, then, of magnifying, beyond all measure, objects which cease to be clear, and which cannot therefore be observed with any usefulness? The lunar soil is formed of materials analogous to those which constitute the terrestrial, and *just as dark*, the lunar globe appearing luminous merely because it is lighted by the sun in the midst of black space. Brought near by a refractor magnifying 1,500 times, certain regions, even then, appear very dark. In the present state of optics the highest magnification that can be *usefully* applied to the observation of the lunar surface is a thousand diameters, which is equivalent to nearly a million times in superficial area.

Definitively, then, the nearest that we can bring the moon to our eyes is 240 miles—240 instead of 240,000. Now I ask, what can be distinguished at such a distance? The appearance or the disappearance of the Egyptian pyramids would certainly happen there unperceived. It is often objected, "but nothing is seen to stir there!" This I readily believe. It would require a famous earthquake (or *moon-quake*) to be perceived from here, and it would also be necessary that, just at that very instant, some terrestrial astronomer, followed by a clear sky and a powerful instrument, should be occupied with the examination of the exact region of the cataclysm. We would be forewarned by no noise; a most fearful catastrophe might happen; the entire moon might burst with a thousand thunders, and not the slightest echo would traverse the space that separates us from her.

When it is declared, then, that the moon is uninhabited, because nothing is seen to move on her surface, it is singularly mistaking the value of telescopic evidence. At a height of 16,000 to 20,000 feet in a balloon, in a clear atmosphere and when the sun is shining, the naked eye distinguishes cities, woods, fields, meadows, rivers, and roads; but nothing is any longer seen moving about, and the impression directly felt (I have often experienced it in my aerial voyage) is that of silence, solitude, and absence of life. No living being is any longer visible, and did we not know that there were reapers in these fields, cattle in the meadows, birds in the trees, and fishes in the water, nothing could make us guess it. If, then, the earth is a dead world, when seen at a distance of only 16,000 to 20,000 feet, what a human delusion it is to assert that the moon is truly a dead world because she appears so at a distance of two hundred and forty miles or more! What can be known of life at such a distance? Assuredly nothing, for forests, plants, cities, *everything* disappears.

MEANS WE POSSESS OF FORMING AN OPINION ON THE STATE OF THE MOON.

The only means we have of forming an opinion on the exact state of the lunar world is to observe with care and to sketch certain districts separately; then from year to year to compare these drawings with the reality, taking into account the difference in the instruments used. There must also be taken into consideration the difference in the illumination according to the sun's height, seeing that the more oblique the sun's rays are, the more visible are the surface projections. A certain amount of variation must likewise be allowed for a difference between the eyes of observers, as well as for transparency of the atmosphere. Now this critical method, which has been applied for some years past, does not confirm the hypothesis of the death of the lunar world. It teaches us, on the contrary, that geological and even meteorological changes are still taking place at the present time on the surface of our satellite.

RECENT CHANGES ON THE MOON.

A volcano larger than Vesuvius formed, or at least increased in such a manner as to become visible, during the course of the year 1875, in the middle of a landscape well known to selenographers. When the moon arrives at her first quarter, the sun begins to light up the surface of the *Sea of Vapors*, a region very happily situated toward the center of the lunar disk. We remark there, among several other beautiful craters, two which have received the names of *Agrippa* and *Ukert*. Around each of the two the land forms a steep declivity, and a plain extends between the counterforts of both. Through this plain we distinguish a sort of river, cut almost in the middle of its course by a little crater called *Hyginus*. I have observed this curious region of the lunar world very often, and I have made a great number of drawings of it, the most complete of which are those of the 31st of July, 1873, 1st of August, 29th of October, and 27th of November of the same year, and the 24th of April, 1874. Now to the northwest of the crater of *Hyginus*, none of the astronomers who have observed and sketched this region had ever seen or described a circular plain, a little over three miles in diameter, which is at present plainly visible there, and which one of our most industrious contemporary selenographers, M. J. Klein, saw for the first time on the 19th of May, 1876. Not to have seen a thing, even in looking at a place where it might have been, does not prove that it did not exist; but when observers have been numerous and attentive, and when the object is very apparent, it is scarcely possible to doubt. Such is the case in regard to the new circular plain, which to-day is the vastest one of the region of *Hyginus*, after *Hyginus* itself. For fifty years, the most careful observers (especially Beer and Mädler, Lohrmann, J. Schmidt, and Neison) have attentively examined and mapped this region without having perceived anything in particular at the point indicated. Moreover, a large mountain in the form of a snail, and which is seen to the north of *Hyginus*, has a beautiful valley which did not exist a few years ago.

There is a society in England whose members all swear fidelity to the moon, and pledge themselves not to forget her for a single month. It is the *Selenographical Society*; it hastened to publish in its journal the details given by Prof. Klein, and the observations which confirmed his discovery. For my own part, as I just now said, although I have not made our satellite the exclusive object of my observations, I have often passed long evenings in studying her curious topography with the telescope; and I have taken among others, in 1873 only, thirty sketches which have always particularly attracted me. Now I cannot recognize the new crater on any of my drawings, while with the same instrument I distinguished it perfectly on the 4th of last September. So, taking these observations all together, it may be affirmed that this volcano is of recent formation.

PHOTOGRAPHS OF THE MOON AND THEIR DEFECTS.

The moon, I repeat, is *not* a dead world, buried in eternal night. We have seen that the greatest *practical* magnifications of the excellent optical instruments of modern times bring her, as yet, only within 200 or 240 miles of our eyes; and that, even if a power of 2,000 should be applied (and that too under exceptionally rare atmospheric conditions), we should only see her at a distance of 120 miles. Now at such a distance as this it is not only impossible to distinguish the *inhabitants* of a world, but the *material works* of these inhabitants likewise remain invisible; roads, canals, villages, cities—even populous ones remain hidden from us through their remoteness. It is true that admirable photographs are taken, and these photographs possess, in a latent state, all that exists in the surface of the moon. If there *are* any inhabitants, they are there—they, their dwellings, their works, their cultivated lands, their edifices, and their cities! Yes, they are *there!* and it is difficult to prevent one's self feeling a certain emotion when, holding one of these photographs in his hand, he says to himself that the inhabitants of the moon are there (if they exist), and that a sufficient enlargement might permit of their being perceived, just as the strange population of a drop of water is seen in the microscope! Unfortunately, these photographs, as excellent as they are, are not perfect; on magnifying them a little, five or ten times, we magnify at the same time the grain of the collodion and the defects of the image, and all soon becomes vague and diffuse, less useful and less agreeable to examine than the original print.

All we can do then is, as I have said before, to confine ourselves to a careful study of the smallest visible details of certain lunar regions, to draw them as exactly as possible, to re-observe them from year to year, and to ascertain the variations, changes, or movements that may have taken place. Well! we have seen that this method has just revealed the formation of a new volcano, larger than Vesuvius.

Let us examine, then, with some detail, the

FACTS THAT HAVE BEEN OBSERVED BY THE PERSEVERING EYES OF ASTRONOMERS,

and let us freely discuss the results of them. Upon the grayish soil of the *Sea of Fecundity*, a sandy plain from whence the water seems to have retired a long time ago, we see a double crater formed of two circular plains, which the industrious selenographers, Beer and Mädler, examined *more than three hundred times* between 1829 and 1837. Behind this double crater, there is a singular white train, which, in form, reminds one of a comet tail; and, on this account, the two German observers have given it the name of the French astronomer, Messier, the most indefatigable of comet seekers. They have studied, described, and drawn with very special care this lunar formation, to which Schroeter had already called attention in 1796. "The two circular plains," say they, "are exactly alike. In diameter, form, height, depth, color of the arena as well as of the surrounding walls, positions of some of the hills joined to the craters, each resembles the other so closely that the fact can only be explained by some strange caprice of accident, or by some law of nature as yet unknown. This double formation is still more remarkable for two trains of light (likewise equal), rectilinear, and directed towards the east." This description is so full, the assertion relative to the perfect resemblance between the two circular mountains is so precise, that we can take it for a point of departure for making absolute comparisons. Now nothing is more curious—I may say more mysterious even, more inexplicable, than the result of these comparisons. Gruythuisen, a very able and conscientious observer, ascertained in 1825 that the western crater was half the size of the eastern, and elongated from the east to the west. On the 13th of February, 1826, a strange fact made itself manifest in the luminous train; the dark band which traversed its center was intermingled with luminous points, "and I believe," writes he, "that I observed *that they did not remain always in the same position.*" At times a veil or mist appeared to extend over these objects, while that under other circumstance, where they ought to have been less visible on account of the effect of the solar light, they were more so.

Another observation. In 1855, Webb ascertained that the eastern crater was the greater of the two, and that the western (or smaller one) was elongated from east to west. Subsequent observations showed that the plain of the eastern crater had not changed, but that of the western had in reality assumed an elliptic form, with a large diameter of 11·20 miles and a short diameter of 7·5 miles. From 1870 to 1875, different observers, furnished with excellent telescopes, have ascertained that the large diameter is 12·42 miles, and the lesser, 6·9 miles. The difference between the two craters, in form and size, says Neison in 1876, is to-day visible even with a refractor of low power. Nevertheless, Klein adds that, according to his own observation in 1877 and 1878, such is no longer the case at present, but there are to be seen anew, on the contrary, those abrupt changes in the form and size of the two craters. The latter fact, then, appears to be incontrovertible; but how comes it that these changes have been able to escape the notice of Beer and Mädler, when they had been ascertained as far back as the year 1824? Had there been no change from 1829 to 1837? Nothing positive has been learned as to the causes that have operated to change the form of the western crater. But what force can we imagine that would displace the great axis of a crater? Such a force is entirely unknown. It might possibly be granted that the rampart has fallen inwardly to the north and south, and outwardly to the east and west. This is the most plausible explanation, but it does not seem sufficient to explain all the changes that have been observed. The two craters are now alike, and now again they are unlike; here the naturalist who is in search of first causes finds himself greatly embarrassed.

Can it be that the lunar globe is still in a pasty and yielding condition in certain spots? And can it be that the attraction of the earth produces strange tide-like movements there? Both hypotheses seem absurd, for, on the one hand, our satellite appears to be as well mineralized as the earth, and on the other hand the earth is fixed in the sky of the moon; but the sun proceeds and there are librations.

Scarcely less enigmatical than the incessant variability of the double crater *Messier* is that of the circular plain *Linné*, in the *Sea of Serenity*. This crater at first was very visible, for we find it already on the lunar map of Riccioli in 1651. Schroeter observed it in 1778, and described it as "a very small round white spot, exhibiting a vague depression." In the time of Lohrmann and of Mädler, this crater had a diameter of 30,000 feet, and its black, shaded interior was visible when lighted by oblique rays; on the contrary, when the sun was high, the whole had the appearance of a whitish spot. In October, 1866, Schmidt remarked that even by an oblique light the crater was no longer visible. The attention of observers generally was directed to this point, and here is what I myself wrote in 1867:

"I had ascertained in the month of April, that, in place of a crater, there was to be seen a *white cloud*, almost circular. On the 6th of May, from 20 minutes before 9 o'clock till the setting of the moon (the latter being two days old), I examined, with different magnifying powers, the point where *Linné* was situated in the dark part of the moon, in order to discover whether there might not be some appearance of volcanic action in that region. Not a glimmer of light showed itself there. This portion of the territory exhibited the same dark shade as the rest. In the northeast quadrant of the satellite was noticed a glimmer, which, although feeble, was very perceptible. This pale light occupied the region of *Aristarchus*, and was doubtless simply the effect of reflected "earth light." It is proper to add, nevertheless, that on this evening the light was more intense than it generally appears.

(To be continued.)